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THE ENGINEER

JUNE 24, 1955

National Coal Board's Report

THE National Coal Board's report and statement of accounts for the year 1954 were issued on Tuesday afternoon. The statistical material included in them has, for the most part, already been published, though the financial statement for the full year reveals that there was a net deficiency of £3,749,100, which increased the Board's accumulated deficit to £17,400,000. The operating profits of the collieries, totalling £16,400,000, were lower than in 1953, and, in addition, the Board had to face a loss of £5,000,000 on coal imports. The Board spent £84,700,000, however, on capital account last year, which was £20,000,000 or so more than in 1953. The report describes the industry's operations during the year and discusses the problem of creating new productive capacity, without which, it is stated, "the industry can neither meet the future demand for coal nor, indeed, maintain, the current level of output." One major difficulty with which the Board is continually trying to contend is the shortage of manpower. At the end of last year there were 705,000 on colliery books. Throughout the year the average manpower figure was 707,200, compared with 712,900 in 1953. The Board's comment is that "this problem is all the more difficult because conditions of work in coal mining can never be so attractive as those in many other industries." About development and reconstruction, the report says that last year 182,000,000 tons of coal, or 85 per cent of the total deep-mined output, was mechanically cut, and 91 per cent of the total deep-mined output was conveyed mechanically from the face. Three new shafts were completed during the year and the deepening of six others was accomplished, and by the end of the year preliminary work on sinking was in progress at thirty-five other new shafts and eleven were being deepened. Nevertheless, the report emphasises that if a coal production of the order of 250,000,000 tons a year, which is the most the Board can at present expect to be available by 1965, is to be achieved, then increased productive capacity must be obtained much more quickly. In fact, the report notes, "some sacrifice of immediate output may be necessary if this work is to proceed apace."

Atomic Energy Agreements

ON Monday last the Prime Minister made a statement in the House of Commons about the civil and military agreements on atomic energy between Great Britain and the U.S.A. He said that the agreements provided the basis for closer co-operation in atomic matters between the two countries. Because of the limitations of the United States Atomic Energy Act of 1954 the military agreement would exclude disclosure of information relating directly to the design and fabrication of atomic weapons. It would, however, permit a valuable exchange of knowledge, on a fully reciprocal basis, on other military aspects of atomic energy, including information relating to the development of defence plans, and to training in the use of, and defence against, nuclear weapons. The agreement would also make possible the joint evaluation of the capabilities of other powers in the use of atomic weapons, and it would allow the exchange of information on the effects of all types of weapons. The Prime Minister went on to state that the civil agreement provided, also on a fully reciprocal basis, for the exchange between the United Kingdom Atomic Energy Authority and the United States Atomic Energy Commission of information on a wide variety of subjects, including the generation of power by atomic means. It also provided for the transfer of materials and equipment between the authorities. It permitted the exchange of information, the sale of equipment, and the use of patent rights between the electricity authorities and private industrial firms working in their respective countries on the development of atomic power. The exchanges would take place on a commercial basis and subject to certain safeguards. The Prime Minister explained that, by permitting the interchange of scientific and technical knowledge between the two Western countries that were most advanced in these matters, the agreement would help to quicken the pace of atomic development and would bring nearer the day when the full benefits of atomic power for peaceful purposes would be at the service of mankind.

Restrictive Business Practices

THE Federation of British Industries has published a pamphlet entitled "Restrictive Business Practices and the Public Interest." The object, it says, is to emphasise that it is unwise to generalise about "restrictive business practices," as circumstances alter cases and each case should be judged on its merits. The F.B.I. seeks neither to justify nor to condemn restrictive practices on principle. After weighing up all the arguments, it is convinced that "serious harm could be done to productive industry, to our national economy and therefore to the public interest if statutory action were to be based on some of the sweeping generalisations that are made." The pamphlet points out that among the Federation's membership there are some industries which limit competition and others which do not. The F.B.I. favours a general system of competitive free enterprise. It believes, however, that in some industries and in some circumstances arrangements which limit competition do not operate against the public interest, and indeed benefit it. The F.B.I. recognises, therefore, that a tribunal such as the Monopolies Commission provides a sensible method of arriving at judgments of the public interest in each case. The pamphlet gives some definition of the kinds of restrictive business practices which are often questioned, and describes what the F.B.I. calls five "inherent checks and limitations on the power of business agreements." In summing up these matters, it says that arrangements between firms which limit competition may help to create the element of stability which enables resources to be used with the maximum efficiency and the minimum waste. They may assist in the provision of funds for new capital equipment and help to create the atmosphere of confidence which is necessary for expansion and greater efficiency. The general conclusion set out in the pamphlet is that there are strong reasons which have induced responsible manufacturers and traders to limit competition, and these arrangements can operate in ways that are of long-term advantage to the national economy. Any sweeping generalisation for or against these practices is out of place, and any action in connection with them must have due regard to the particular circumstances of particular cases.

Food Research

THE Department of Scientific and Industrial Research has published the report of the Food Investigation Board for 1954. The work of the Board is conducted under the general direction of Dr. Franklin Kidd, F.R.S., and in the report there is presented a survey of the research activities designed to assist the treatment and handling of meat, fish, fruit and vegetables. It is stated that the "distribution of effort" in the Food Investigation Board's programme is: basic research, 40 per cent; applied research and development work, 45 per cent; and advisory work, 15 per cent. Research work which is described in some detail in the report includes experiments on the freezing of beef carcases, the electronic sterilisation of food, the electrostatic smoking of fish, and problems concerned with the storage and preservation of home-grown fruit. Commenting on the Board's co-operation with industry, the report stresses that the attitude of mind both of management in the industries and trades concerned and of the Food Research Organisation is of primary importance. On the one hand, it is observed, industry must recognise that benefits cannot usually accrue from even the most successful researches without changes in existing organisation and methods. It is urged that "industry must acquire sufficient faith in research and scientific development to be prepared to undertake such changes," and, in order for them to be effective, industry should employ its own technologists as distinct from, and in addition to, technicians only capable of operating old-established methods. On the other hand, the report continues, the Food Investigation Board and its research workers must be sympathetic and appreciative of industry's problems and must be in a position to speak the language of the practical man. Co-operating industry must be allowed a full share in the selection of the research objectives and in the planning of the more applied research programmes. The Board suggests, therefore, that the secondment of industrial staff to research and of research staff to industry in order to help the implementing of research results should be encouraged.

Invention Trends

THE report of the Comptroller-General of Patents, Designs and Trade Marks for 1954 shows that 37,871 patent applications were made during the year and 17,985 patents were sealed. The section of the report which deals with invention trends says that, last year, in the electrical engineering field considerable interest was shown in the development of the remote control of underground mining equipment, in the use of transducers in protective systems, in the construction of small current relays for use in high-speed aircraft, and in the electric control of gas turbines. In television inventions, the main emphasis was on multiplex transmission of colour television and on display devices and the associated circuitry in receivers. The report goes on to mention the attention given during the year to electric computers and allied devices, the trend being towards the production of more compact computers and of data-storage or "memory" devices. In the aircraft field, there was increasing activity in the use of jet reaction for obtaining direct lift, and also in helicopter development. The development of electric flight simulators also attracted a good deal of attention. In a reference to inventions concerned with machine tools, the report mentions the interest shown in the application of electronic control systems. Another matter mentioned in the report is the considerable interest taken in the production of hollow explosive charges for blasting, and in the use of explosive-operated hand tools for firing spikes and bolts into structures. The report comments on the concern caused by the continued inability of the Patent Office to recruit suitably qualified assistant examiners in sufficient numbers, even to replace normal wastage by retirement and death. Unless and until the strength of the examining staff is considerably increased, it is stated, there can be little hope of preventing the large arrears of unexamined specifications (25,879 at the end of last year) from mounting still further.

Vertical Boiler Locomotives

By R. A. S. ABBOTT*

No. V—(*Concluded from page* 836, *June* 17*th*)

The study of the history of the industrial locomotive is a fascinating subject, quite outside the scope of ordinary railway and locomotive literature, and one which offers a wide field for research. For many years the writer has made the industrial and light locomotives with vertical boilers his special interest, and as no previous history of this type of locomotive has ever been published it is hoped that this excursion into a little explored by-way of locomotive engineering will prove welcome to both the engineer and historian.

BAGULEY

IN the latter half of 1924, a light steam locomotive of unusually interesting design was built to the order of the Egyptian Delta Light Railways by Baguley (Engineers), Ltd., Burton-on-Trent. This locomotive was designed to haul one or two passenger coaches only on a suburban service at about 20 m.p.h. Built for a rail gauge of 2ft 5½in (75cm), it had a vertical boiler at one end and a vee type compound engine at the other, the engine driving all four wheels through a clutch, change speed gear, transverse shaft and silent chains, both the boiler and engine being of the kind designed by Mr. Thomas Clarkson and constructed by Clarkson's Steam Motors. Apart from the Clarkson thimble tube boiler, this locomotive was unusual in that the engine was not intended to be started and stopped at each halt, but ran continuously as long as the locomotive was in use, movement being controlled by the clutch. A full description of this Baguley-Clarkson design appeared in *Engineering* for December 25, 1925.

CLAYTON

A series of geared steam locomotives with vertical boilers was introduced by Clayton Wagons, Ltd., Abbey Works, Lincoln, in 1927, but due to the small number built and the apparent lack of interest taken by the technical Press at that time, exact details of these locomotives are now very difficult to obtain, although THE ENGINEER for April 8, 1927, pages 381 and 382, did publish details and a report of the trials of the first locomotive. The design, illustrated by Fig. 31, was known as "type A." The locomotives were four-coupled with inside axleboxes, and the general arrangement comprised boiler at one end of the frame, a horizontal two-cylinder engine beneath the floor of the cab, with the water tank and coal bunker at the other end. The boiler was very similar to the early Sentinel design, except that it had twelve rows of cross water tubes instead of eight, while the superheater consisted of eight coils in place of five, as in the Sentinel.

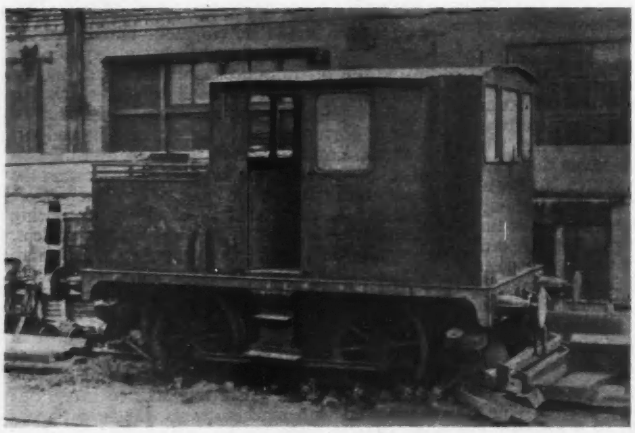


Fig. 31—"Type A" Clayton locomotive, built 1927, for Smith-Clayton Forge, Ltd.

The boiler was 4ft 10⅜in high, and had a heating surface of 85 square feet. It was constructed with the inner shell attached to the outer shell by means of two machined flanges with asbestos joints and bolts, so that it could be dropped down through the bottom for the scaling of the tubes. Two safety valves were fitted and the boiler worked at a pressure of 275 lb per square inch, while a superheating coil in the top of the firebox supplied steam at a temperature of about 600 deg. Fah. The feed water could be supplied either by a direct-acting pump or by an injector and means were provided for warming the water from the exhaust steam.

The engine was a two-cylinder, horizontal, high-pressure, totally-enclosed unit, with cylinders 6¾in bore by 10in stroke. The cylinders, crankcase and the gearbox of the reduction gearing were bolted together so as to form one unit, and the combined set was supported at the gear end by bearings surrounding the main driving axle, while the other end was carried by a swinging link attached to a point midway between the cylinders and crankcase, and fixed by spherical washers and rubber buffers to one of the cross bearers of the main frames. This link was arranged in such a position that it carried a large part of the weight of the engine, which was thus spring borne. The engine had piston valves arranged below the cylinders to ensure drainage, and the valve gear was rather unusual. There were only two eccentrics, one for each cylinder, and they were mounted on a layshaft driven off the crankshaft by gear wheels. In order to reverse the engine, the eccentrics were moved across the shaft from one side to the other. This layshaft was hollow and contained a sliding shaft in which notches were cut to form two inclined planes at right angles to one another—one for each eccentric. By moving the sliding shaft endways the eccentricity could be varied from full ahead to full astern. It will be understood from this brief description of the valve gear that it was yet another variation of the old Dodds wedge motion.

Other particulars of "type A" locomotives were: total length over buffers, 18ft 4in; width between frames, 4ft 0¼in; wheelbase, 7ft; coupled wheels, 3ft 6in diameter; gear ratio, 3·04 to 1; speed at 500 r.p.m., 20·5 m.p.h.; weight with half capacity of coal and water, 20 tons. It should be understood that these locomotives were derived from the power bogie of the earlier type Clayton railcar, which, in its turn, was a direct "offshoot" of the Clayton "under type" steam wagon—the boilers and engines being the same in all three vehicles.

It is thought that only two or three of these "type A" locomotives were built, one of which was ordered by Earle's Cement Works, of Hull. Later, it went to Pilsley Colliery and was finally bought by Downings, of Barnsley, for resale; it was in this firm's yard in August, 1950. A second locomotive started work when new at Smith-Clayton Forge, Lincoln, and was there in a derelict state in July, 1950.

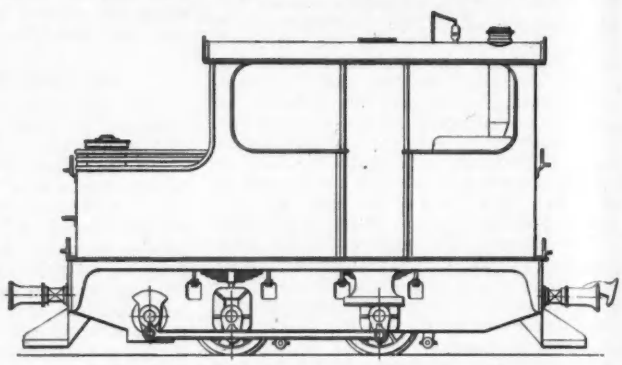


Fig. 32—"Type C" Clayton locomotive for narrow gauge

In addition to the locomotives described above, there was also another design known as "type C." As will be seen from Fig. 32, these locomotives were different in appearance. This "type C" was available in two sizes, both of which had short wheelbases of 3ft 6in and 5ft respectively, and had 2ft diameter wheels hidden behind a "skirt" of sheet metal; they were not fitted with outside axleboxes as might at first be thought from casual inspection of the drawing. The two-cylinder, horizontal, high-pressure, totally-enclosed engine developed 100 b.h.p. These locomotives were for gauges of 2ft up to 1m, and had a water capacity of 200 gallons, a bunker capacity of 5 cwt, and could be supplied weighing 6, 8 or 10 tons in running order. It will be noticed that the drive to the coupled wheels was by rods from a jackshaft—rather on the lines of a modern diesel locomotive.

After the closing down of the works of Clayton Wagons, Ltd., the drawings, patterns and templates passed into the hands of Richard Duckering, Ltd., Waterside Works, Lincoln, who then undertook to supply spare parts for both locomotives and railcars.

ATKINSON-WALKER LOCOMOTIVES

The Atkinson-Walker locomotives constructed by Atkinson Wagons, Ltd., Frenchwood Works, Preston, are, like the Clayton locomotives described above, surrounded by a certain amount of mystery, in that few details have appeared in the technical Press, and the

* Member, Newcomen Society; Member, Industrial Locomotive Society.

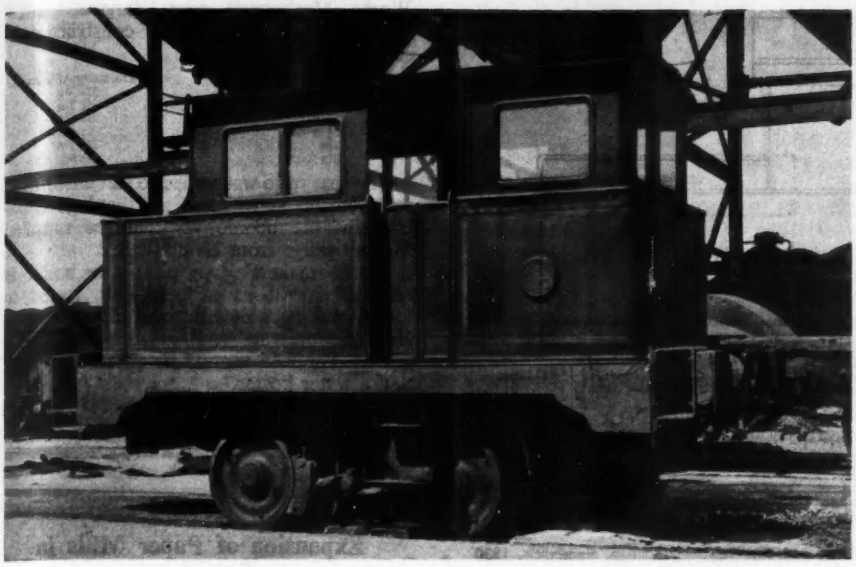


Fig. 33—Atkinson-Walker locomotive, class "C," at Tottenham Works, Eastern Gas Board

firm's successors, Atkinson Lorries (1933), Ltd., of Winery Lane, Walton-le-Dale, have preserved no records. The connection with the project by Walker Brothers (Wigan), Ltd., Pagefield Ironworks, Wigan, was mostly financial, together with the manufacture of certain mechanical parts and the supply of subsequent spares. They did not take part in the design.

These locomotives followed the usual practice in modern geared designs with the vertical boiler at one end, water tanks at the other, and the engine in the centre, the whole being covered by an all-over cab. The total number of locomotives is thought to have been no more than about twenty-five and all built between 1927 and 1931.

There were at least six different classes constructed, varying in weight from 5 to 40 tons, and they may be briefly summarised as follows :—class "A" had two cylinders and 3ft diameter wheels ; class "B" had three cylinders, 3ft diameter wheels, a boiler pressure of 280 lb per square inch, 125 square feet of heating surface, a grate area of 7 square feet, and a weight of 35 tons ; class "C" differed from all the others in having inside bearings for the axles and two horizontal cylinders, wheels 2ft 3in diameter, a working pressure of 230 lb per square inch, and a weight of 10 tons ; class "D" had a four-cylinder engine and ran on three axles. The above four classes were all for the standard gauge.

A locomotive was supplied to the Clogher Valley Railway in Ireland during 1928 (Works No. 114), and it had two cylinders, wheels 2ft 6in diameter, a working pressure of 280 lb per square inch, 60 square feet of heating surface, a grate area of 3·3 square feet, and a weight of 12 tons. The gauge of this railway was 3ft.

Yet another design of narrow-gauge locomotive was supplied for Singapore, with the two axles coupled by external chain and fitted with an open-sided canopy cab.

The engines fitted to all the locomotives were of the double-acting, high-pressure, uniflow type, as developed by the makers in their steam wagons, and were totally enclosed with the big ends and main bearings lubricated under pressure, steam being admitted through ball valves controlled by cams and long pushrods. The two-, three- and four-cylinder engines were substantially similar, the bore being 7in diameter, and the stroke 10in, the various parts being standard throughout the range. With the exception of class "C," the engines were set vertically on the longitudinal centre line of the locomotive, driving by enclosed bevel pinions a transverse shaft carrying a chain sprocket at each end, from which separate roller chains drove each axle, the axles being located by adjustable radius rods. In the case of the six-wheeled locomotive of class "D," the axle under the water tank was driven by chain from the centre axle.

In the water-tube boiler riveted joints were entirely dispensed with except for a double-riveted butt strap along the longitudinal joint of the top and bottom shell. The firebox, squared above the grate to receive the cross water tubes, was pressed in halves and electrically welded at the seams, the firebox then being welded to the outer shell by the same method, the whole construction being virtually one piece. The tubes, arranged crosswise, were inclined towards the front of the boiler to ensure active circulation of the water. Firing was effected through a chute, level with the footplate, fuel being distributed by a special firing tool, while a circular airtight door in the front of the firebox was provided for cleaning the fire and "lighting-up." A superheater consisting of a solid drawn steel tube in the form of a coil was housed in and supported by the cast iron uptake, and had sufficient heating surface to provide a temperature of 600 deg. Fah. Locomotives intended for passenger work were fitted with feed water heaters.

A very full description of class "B," with detailed illustrations of the engine and boiler, appeared in *The Locomotive* for 1928, pages 207–210 ; also illustrated on page 210 is the narrow-gauge unit sent to Singapore. The 3ft gauge locomotive for the Clogher Valley Railway is illustrated and described in *The Narrow-Gauge Railways of Ireland*, by H. Fayle, pages 42 and 45.

Of the two designs illustrated here, Fig. 33 shows class "C" (Works No. 113), now working at the Tottenham works of the Eastern Gas Board, while Fig. 34 is a recent photograph of the solitary six-wheeled class "D," originally supplied to the Oxford and Shipton Cement Company in 1928 (Works No. 110), but last reported to be at Alpha Cement, Ltd., West Thurrock. A sectional side elevation of this locomotive was published on page 243 of the *Journal* of the Junior Institution of Engineers for 1929.

Willans-Kerr

The geared steam locomotive, with vertical water-tube boiler, designed by Mr. Kyrle W. Willans and built by Messrs. Kerr, Stuart and Co., of Stoke-on-Trent in 1928, has been very fully described in *The Locomotive* for 1929, page 56, and in the *Journal* of the Junior Institution of Engineers for March, 1929, pages 248–263 ; it is therefore unnecessary to describe it in detail here. The boiler, mounted in the cab, had much in common with the Loftus Perkins boiler, but was modified drastically in the method of connecting the boiler components to facilitate the cleaning of every part of the boiler. The central portion of the frame was occupied by a cylindrical water tank, while across the frames at the front was mounted the totally enclosed two-cylinder vertical engine. The cylinders were 6in diameter, with a stroke of 8in, and had separate inlet and exhaust piston valves actuated by a modified Hackworth gear. The drive was by reduction gear to the countershaft and thence by chain to the front axle, the two axles being coupled by chain. This loco-

Fig. 34—Atkinson-Walker six-wheeled locomotive, class "D," at Alpha Cement, Ltd., West Thurrock

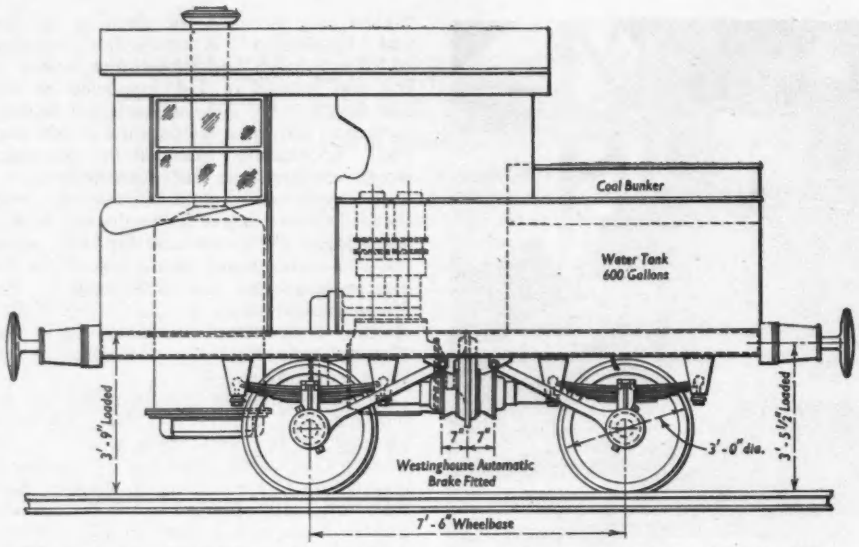


Fig. 35—Locomotive by Fodens, Ltd., for Palmer, Mann and Co., Rookery Bridge, Sandbach, 1930

motive was supplied to Balfour, Beatty and Co., the contractors.

Fodens

It may not be generally realised that Fodens, Ltd., Elworth Works, Sandbach, maker of traction engines and steam wagons, was also responsible for building one vertical boiler geared locomotive. It is not known under what circumstances this locomotive came to be designed, but the maker's general arrangement drawing, reproduced here (Fig. 35), is dated October 17, 1927, and from it the layout of the boiler, engine and water tanks will be clearly seen. The engine was the Foden "type E.2," with two high-pressure cylinders having a bore of 7in with a stroke of 10in, giving a maximum b.h.p. of 75, the motion being totally enclosed in a crankcase with crankshaft mounted on roller bearings.

The drive from the crankshaft to cardan shaft was by double helical gearing, thence by worm and worm wheel to each axle. The wheels, 3ft in diameter, were on a wheelbase of 7ft 6in, the axles being located by radius rods.

The boiler, of the water-tube type, working at 250 lb per square inch, had a heating surface of 62·25 square feet and a grate area of 3·66 square feet, being fed by one pump and one injector, while the superheater in the smokebox was of the standard pattern as fitted to Foden "type E" road vehicles. A coal consumption of 6 lb per mile was claimed. The tank capacity being 600 gallons, with a large space for coal, it would have been possible to undertake a continuous journey of 220 miles without refuelling, and a speed of 40 m.p.h. could be maintained. Although designed in 1927, this locomotive was not built until 1930 (Works No. 13,292) and was then supplied to Messrs. Palmer, Mann and Co., Rookery Bridge, Sandbach.

It possessed many refinements and was of high-class workmanship in every way, but this locomotive had a short life and was scrapped in 1939.

The writer is not so sanguine as to suppose that the foregoing survey is complete; it is possible that there are other locomotives—probably "one-off" jobs—whose builders have never been recorded.

It should, however, be clearly understood that "hybrid" locomotives built from second-hand parts have no place in this survey.

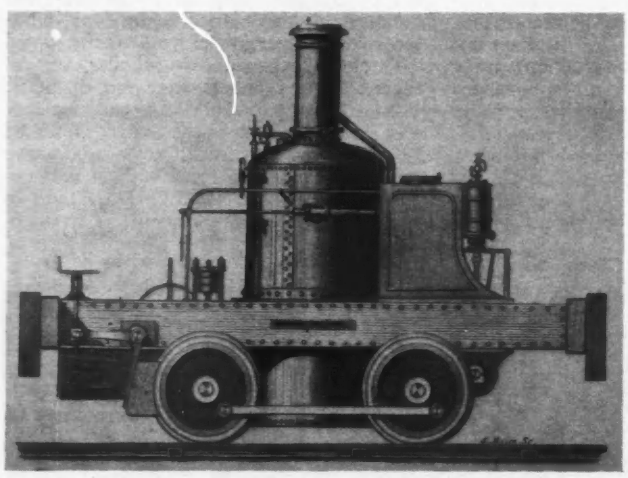


Fig. 36—George Russell and Co.'s locomotive, built circa 1875

In conclusion, thanks are due to all who have assisted in the compilation of this article by providing historical data, especially those engineering firms who have so willingly searched their archives for information, and also the following:—M. Carter, of Barrow; J. Proud, of Lancaster; H. A. Samuel, chief engineer, Seaham Harbour Dock Company; N. G. Robson, of Newcastle; J. B. Latham, of Woking; D. Tew, of Cambridge; S. H. Pearce Higgins, of Liverpool; Ivor E. Davies, of Penmaenmawr; D. Jones, of Penygroes; M. Roberts, of Nantlle.

Acknowledgments for the loan of photographs or drawings will be found under the appropriate illustrations.

Addenda

Since writing the above information has come to hand relating to a series of vertical boiler locomotives built by George Russell and Co., Alpha Steam Crane and Engine Works, Motherwell, near Glasgow. These locomotives, Fig. 36, were constructed in six sizes, as follows:—

Diameter of cylinders	Diameter of wheels
4in	2ft 3in
4½in	2ft 3in
5½in	2ft 6in
6½in	2ft 6in
7in	2ft 9in
8in	2ft 9in

The gear ratio was varied to suit customers' requirements as to speed and haulage capacity, and the locomotives could be supplied for any gauge from 2ft upwards.

In the makers' description the boiler is said to have been of best iron, tested to 200 lb per square inch, and fitted with a Bourdon pressure gauge and Salter safety valve. The feed was by pump and the tank had a water heater.

These locomotives are thought to have been in production about the period 1875, but the maker is unable to confirm this.

Expansion of Paper Mills in Tennessee

A scheme has been formulated by the Bowater Paper Corporation, Ltd., to expand the Bowater's Southern Paper Corporation Mills at Calhoun, Tennessee, U.S.A., which were opened last year and produce newsprint and kraft pulp at an annual rate of 160,000 tons and 65,000 tons respectively. It is expected that the programme will be completed by the end of 1956 and that production of newsprint will rise to 270,000 tons per annum in the following year. However, because of the complexity of the scheme it will be undertaken in three parts and phase one is already in hand and due for completion by October of this year. The work involves the addition of a fourth stage brown stock washer in the sulphate mill, increased bleaching and storage facilities and the addition of extra thickening equipment to the six vacuum thickeners already operating in the groundwood mill.

Practically the whole of the mill operations will be affected by the second phase of the programme, which will in the main consist of the installation of a third newsprint machine, about 276in wide and capable of a speed of 2000ft to 2500ft per minute, and ancillary equipment. The machine, which will be similar to the two already in operation, will be driven by a General Electric multiple generator, electronic-amplidyne controlled, while three main motor generator sets will provide power to drive each section by a d.c. electronically regulated motor. The Beliot Iron Works, Beloit, Wisconsin, will manufacture the newsprint machine and the heavy-duty, double-drum winder designed to operate at a maximum speed of 6000ft per minute. To the existing three chain-suspended barking drums in the wood preparation department it is intended to install a rotary barking drum together with the necessary conveyors to link up with the present system. The bank of five digesters in the sulphate mill will be increased to six, the new unit being of stainless steel construction instead of the carbon steel of the earlier machines. In the groundwood mill the total number of grinders will be raised to fourteen with the installation of six Waterous Great Northern improved grinders, each capable of producing 50 tons of groundwood pulp per day and each powered by a 6000 h.p. synchronous motor. Some additional thickening and storage facilities will be provided and space left for the mounting of two more grinders in the future.

The programme will raise the demand for power from 45,000kW to 80,000kW, of which 10,000kW will be supplied by the Tennessee Valley Authority, while a condensing automatic extraction turbine generator will provide the remaining 25,000kW. Steam for the turbine will be supplied at 850 lb per square inch gauge and 900 deg. Fah. at 350,000 lb per hour by a Babcock and Wilcox boiler equipped for either gas or oil firing with provision made for using pulverised coal.

The third phase will involve the installation of equipment to provide pulp from local hardwoods.

Note on Carpet Graphs

By J. R. ELLIS, M.Sc.(Eng)., A.M.I.Mech.E.

THE engineer is often required to present information concerning three variables in graphical form. The most familiar method of achieving this is to plot a family of curves showing the relation between two of the variables for a number of fixed values of the third. When the relation between this third variable and either of the other two is needed further graphs have to be plotted, in every case relegating one variable to the position of a constant for each curve. Thus an overall picture of the interplay between the variables is not obtained from any one graph. Further, if information concerning intermediate values of the third variable is required, this may only be obtained by means of a second graph, as referred to above; to interpolate directly between the original curves is a matter of guesswork.

The carpet graph method of presentation of such information, however, provides a representation of the role of each variable on a single sheet of graph paper, using the rectangular co-ordinates usually printed on graph paper as the scale for each variable. Where interpolation of the results is necessary, accuracy comparable with that obtained by plotting a second graph may be obtained without further effort.

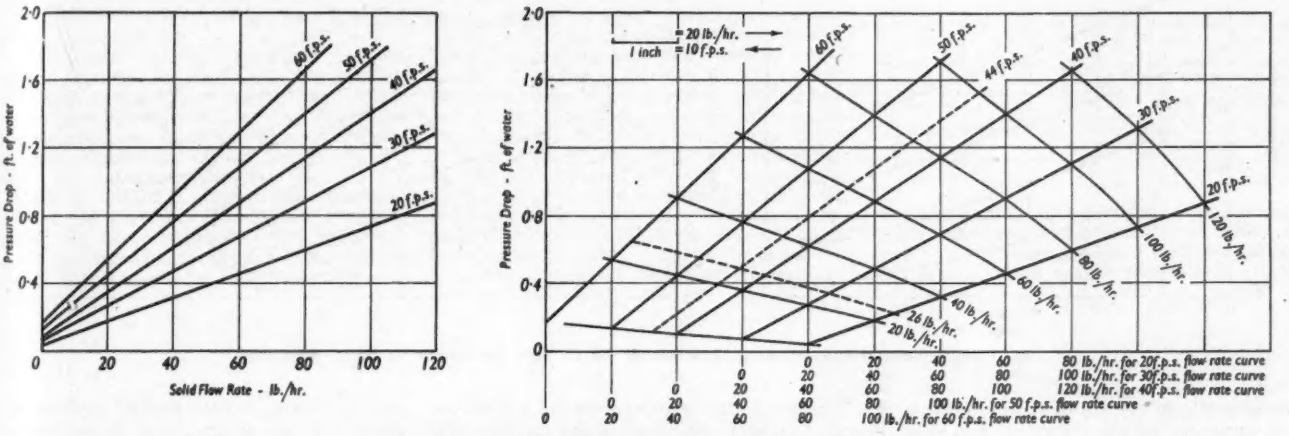
The system was developed at the National Physical Laboratory and has been in use since about 1945, mainly for the presentation of aerodynamic data, and has been widely used in the aircraft industry for this purpose. An article by Yates[1] describes the application of the system to aerodynamic and thermodynamic data, while Tatham[2] and McIntosh[3] consider its uses in aircraft structures and concrete mix design, respectively.

Construction of the carpet is straightforward and involves little more effort than is required by normal methods. The family of curves is reproduced, but for each curve the origin of the co-ordinate system is moved by an amount proportional to the constant value of the third variable for which this particular curve was obtained. The appearance of the carpet (e.g. Fig. 2) may be compared with that of the normal plot (Fig 1) and has the appearance of the family of curves, each plotted on a separate sheet of transparent paper and the pile of paper shuffled sideways. Fig. 1 shows a typical family of curves, each curve representing changes of two variables for a fixed value of the third: the curves have a common origin. In Fig. 2, the same curves are redrawn, but for each 10ft per second increment of flow velocity, the origin has been moved 1in to the left. The origin of each curve is marked here showing the displacement with increase of flow velocity. Using these scales, the measured drop at which a particular flow rate (e.g. 40 lb per hour) is obtained, may be marked on to each flow velocity curve. Joining these points gives a line of constant flow rate. This process is repeated for various constant flow rates and the characteristic carpet appears.

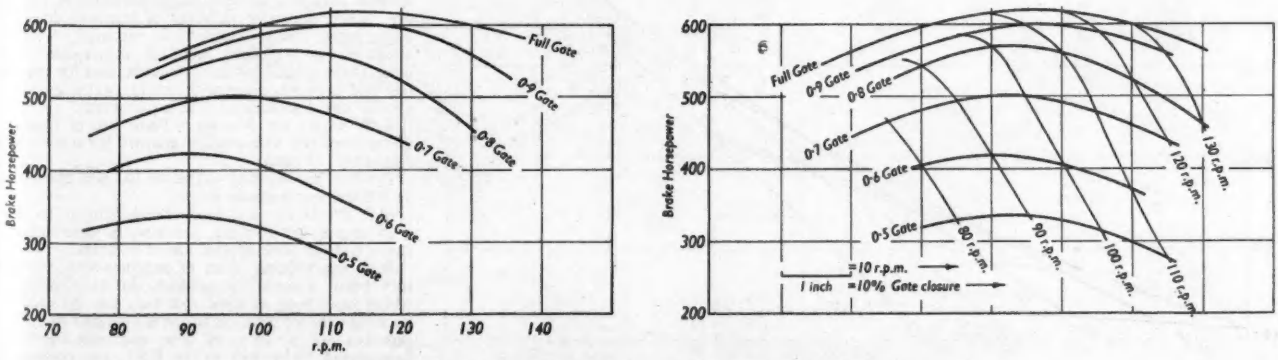
The direction of the displacement of the origin may be either vertical or horizontal, with positive or negative increments, thus there is a wide choice and the final shape of the carpet will depend entirely on this; a preliminary sketch is often useful in obtaining an open pattern which is easily read, while if this is ignored the resulting carpet may be unintelligible. To illustrate this point, Fig. 1 has been redrawn in Fig. 9, reversing the direction of the positive increment of flow velocity. The resulting carpet is of little practical value.

Interpolation of the carpet is straightforward. Referring to Fig. 2, if it is desired to find the pressure drop for a flow rate of 26 lb per hour and a flow velocity of 44ft per second, the appropriate curves may be drawn using the graph paper scales. Each constant flow rate line represents the pressure drop plotted against flow velocity. The scale being such that 1in gives a change in flow velocity of 10ft per second, increasing positively from right to left. Thus, at any fixed flow rate a flow velocity of 44ft per second will be 4/10in horizontally to the left of the 40ft-per-second line. Joining such points gives a curve of 44ft per second flow velocity.

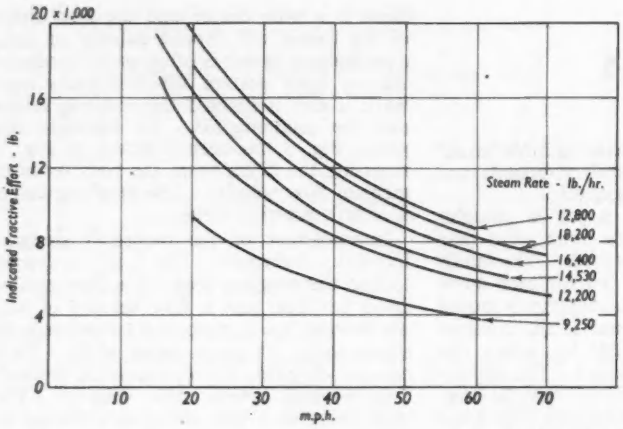
Similarly, each of the constant flow velocity lines shows the flow rate against pressure drop at constant velocity. The flow rate of 26 lb per hour will be 3/10in horizontally to the right of the 20 lb per hour line since here 1in represents a change of 20 lb per hour in flow rate, positively increasing from left to right. Thus, a curve of constant flow rate 26 lb per hour may be drawn. The inter-section of these two curves gives the desired flow conditions. The pressure drop (feet) is then read off the vertical scale. In practice it is not necessary to produce both curves: assuming that the 26 lb per hour flow rate curve is obtained, the flow velocity of 44ft per second will be on this 4/10in

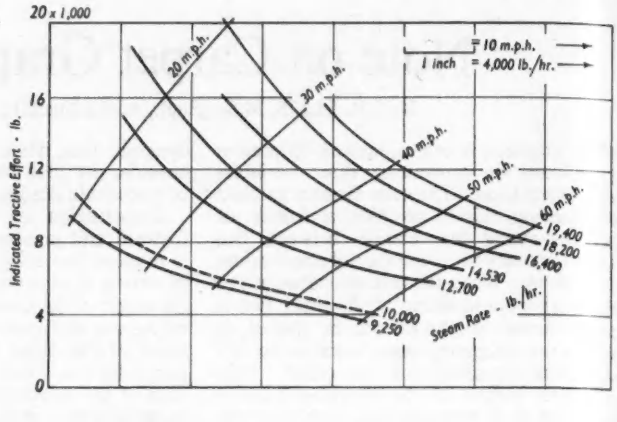

Pressure Drop - ft. of water
Solid Flow Rate - lb./hr.
60 f.p.s.
50 f.p.s.
40 f.p.s.
30 f.p.s.
20 f.p.s.
1 inch = 20 lb./hr.
1 inch = 10 f.p.s.
44 f.p.s.
26 lb./hr.
20 lb./hr.
40 lb./hr.
60 lb./hr.
80 lb./hr.
100 lb./hr.
120 lb./hr.
80 lb./hr. for 20 f.p.s. flow rate curve
100 lb./hr. for 30 f.p.s. flow rate curve
120 lb./hr. for 40 f.p.s. flow rate curve
100 lb./hr. for 50 f.p.s. flow rate curve
100 lb./hr. for 60 f.p.s. flow rate curve

Figs. 1 and 2—Mass flow/pressure drop at various velocities

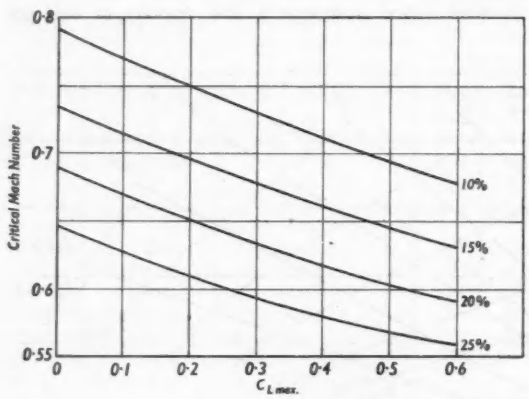


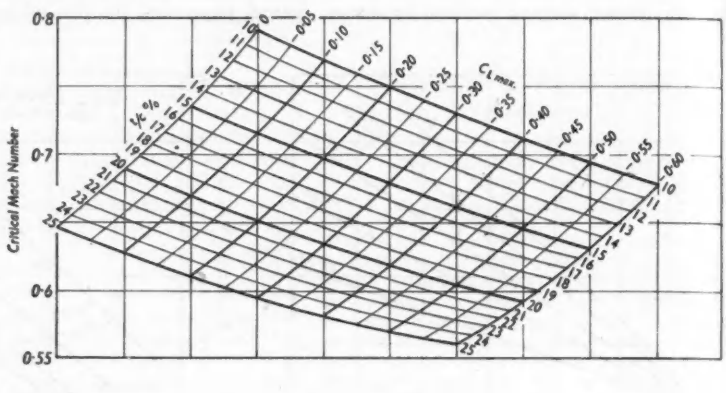
Figs. 3 and 4—Francis turbine, b.h.p./r.p.m. at various gate openings, per cent





Figs. 5 and 6—Indicated tractive effort/m.p.h. and steam rate





Figs. 7 and 8—Relation between critical Mach number and C_L max. for various t/c ratios (wing only)

horizontally to the left of the intersection of the curve and the 40ft per second flow velocity line.

Some further examples of carpet graphs are given. Figs. 3 and 4 show characteristic curves of brake horsepower and revolutions per minute at various gate openings for a Francis turbine. From this carpet the gate opening required to produce a given combination of revolutions per minute and brake horsepower may be read directly.

Figs. 5 and 6 give the indicated tractive effort obtained at various steam rates and speeds from a steam locomotive ; comparing the carpet with the original presentation, the effect of altering the steam rate is demonstrated more clearly, and again the carpet may be used to estimate the steam rate required for a given tractive effort and speed.

This particular carpet shows the use of the method when the values of the variable held constant during the experiment have irregular variations, the displacements of the origin in this case is such as to demand more care in plotting than in the other examples where the displacement is regular.

Figs. 7 and 8 are the critical Mach number versus C_L max. and thickness/chord ratio for an aerofoil. These particular examples have not been chosen for their utility but merely to illustrate the method.

An extension of the method using the vertical scale to permit the inclusion of a fourth variable is known as the " lattice " graph. The characteristic appearance of this is of a series of carpets displaced from each other.

The preparation of design data sheets for use in drawing offices and of performance charts for various machines, in the form of carpet or lattice graphs, would be of value due to the facility of interpolation afforded.

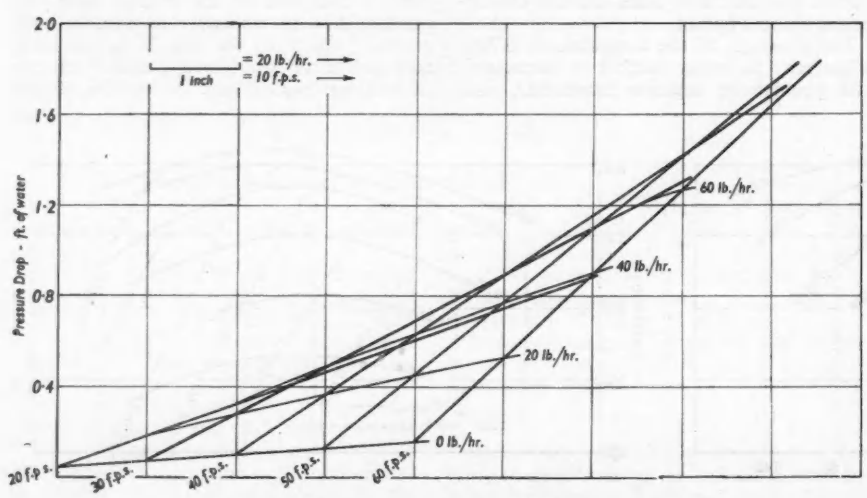


Fig. 9—Mass flow/pressure drop with flow direction reversed

REFERENCES

[1] Yates, A. H., " Carpets and Lattices," *Aircraft Engineering*, January, 1946.
[2] Tatham, R., " Technical Notes," *Journal R.Ae.S.*, February, 1953.
[3] McIntosh, J. D., " Methods of Plotting Several Variables," *Magazine of Concrete Research*, December, 1949.

The graphs, Figs. 1, 3 and 5, were obtained from :—
Fig. 1.—" Pressure Drops in the Pneumatic Conveyance of Solids." Pinkies. *Journal Applied Mechanics*, December, 1952.
Fig. 3.—" A Treatise on Applied Hydraulics." Addison, page 228.
Fig. 5.—" An Outline of Locomotive Testing Methods Used at the Swindon Testing Station." British Railways, 1952.

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ALUMINIUM ALLOY SECTIONS FOR MARINE PURPOSES

No. 2614 : 1955. Price 3s. 6d. This new British Standard is complementary to B.S. 1161 " Aluminium and Aluminium Alloy Sections." It defines three series of structural sections designed mainly for marine use. Their design is the result of intensive development work, which took into account forming behaviour and modern welding techniques. The three kinds of sections are tabulated, and for the 4in size and upwards alternative thicker webs are listed for use where necessary. The sections are :

Bulb Angles for Riveting.—These are of conventional form but with profiles adapted for economical disposition of metal.

Tee-Bars for Welding.—The tee-bar was chosen as an efficient symmetrical shape.

Bulb Plates for Welding.—These, similar to the bulb angles for riveting, are also of conventional shape and facilitate application of brackets.

Both the welding series of sections have a small root bead or table for welding, the dimensions of which have been so fixed that they can be used as backing bars for butt joints. It is intended to review this standard in two years' time, and users are therefore invited to submit to the B.S.I. any comments and suggestions they may wish to make for revision.

Mach 3 Wind Tunnel

The first medium-size supersonic wind tunnel to be operated privately in this country was opened by Lord Brabazon of Tara on Monday, June 13th, at the Armstrong Whitworth guided missile plant at Whitley. The tunnel has a Mach number range of 0·3 to 3·0 and can operate with stagnation pressures from 0·2 atmosphere to 1·5 atmospheres absolute, and in certain cases to 2·8 atmospheres. It has a working section of 19in by 14·5in and the Reynolds number range is from 1×10^6 per foot to 6×10^6 per foot at all Mach numbers above 1·6. The tunnel is of the continuous closed circuit layout equipped with two centrifugal compressors which can be operated in parallel or in series and driven by a single electric motor with a continuous rating of 7700 h.p. and a two-hour rating of 10,000 h.p.

PRELIMINARY running has now commenced on the Mach 3 wind tunnel which has been installed by Sir W. G. Armstrong Whitworth Aircraft, Ltd., at Whitley, near Coventry. It is the first privately owned wind tunnel of its size in Great Britain and will help to meet the great need for tunnel equipment in this country in the high-speed range. The principal details of the tunnel, illustrated in Fig. 1, are given in the accompanying table.

It is claimed that the capital cost and the running cost are the lowest for any existing tunnel with comparable testing facilities. Much of the instrumentation and control equipment have been developed by the Armstrong Whitworth Company under the direction of Dr. W. F. Hilton, its chief aerodynamicist.

One of the important details of this continuous closed circuit wind tunnel is its relatively rapid starting and stopping characteristics, which are usually a disadvantage with this kind of wind tunnel. It was found that by suitable design of the motor and switchgear a starting sequence of only one minute was feasible and by cooling the liquid starter, two starts per half-hour could be maintained indefinitely.

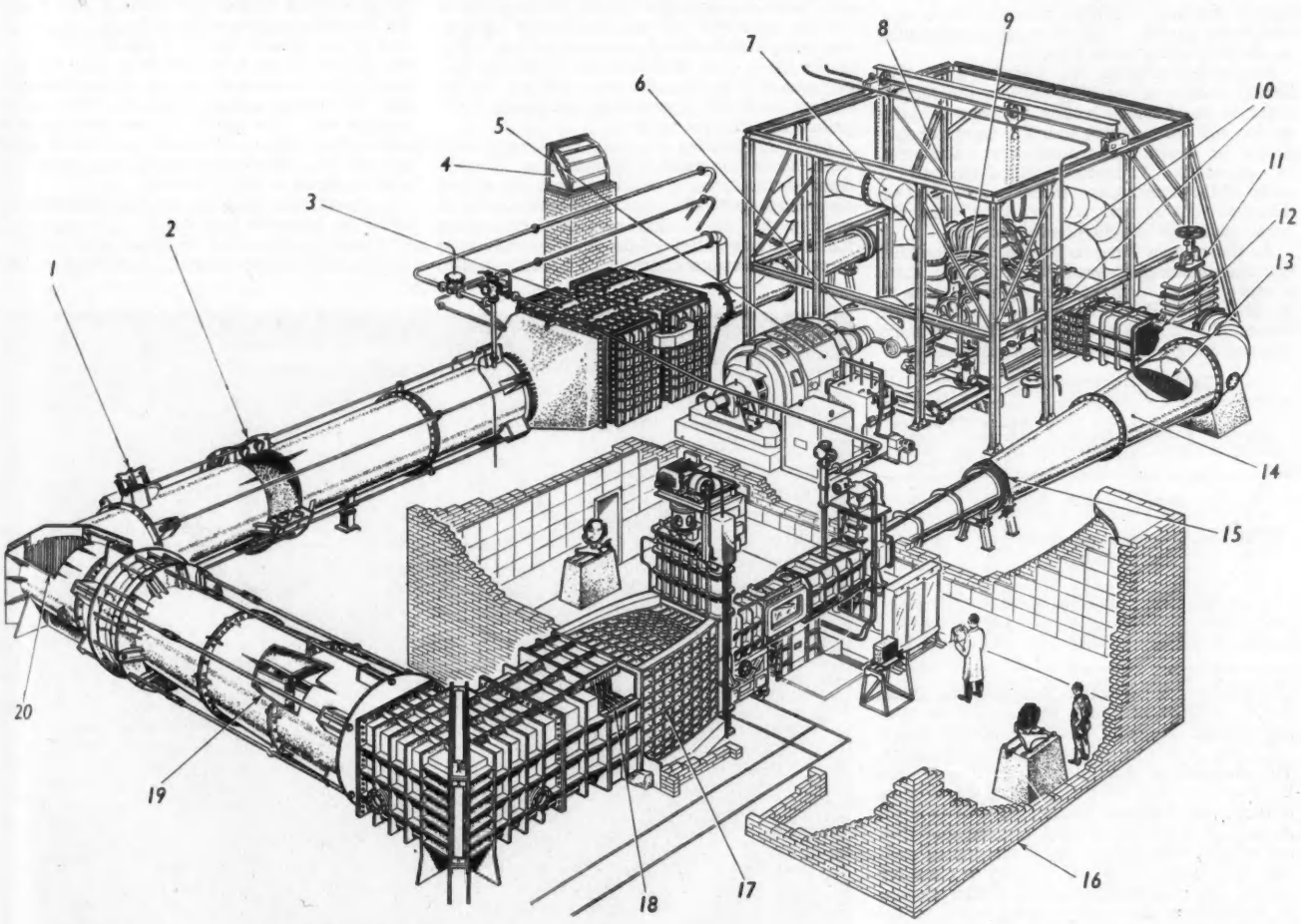
At supersonic speeds there is the additional requirement that supersonic flow must be established past the model as quickly as possible, in order to reduce the considerable loads on the strain gauge sting when starting or stopping. This is done by starting up the motor-compressor set with the compressor inlet butterfly valves closed. By means of a switch, oil pressure can be applied suddenly to these valves, causing them to open (or to close) in three and a half seconds. This gives a sudden start (or stop) which is nearly as quick as an intermittent tunnel. This switch can be operated as frequently as required, leaving the compressor set running at full speed. A small leakage past the butterfly valves ensures adequate air cooling of the compressors, which are surging during this phase of the operation. Indefinite surging of centrifugal compressors does not cause harm to the compressor set.

Design of Working Section.—Supersonic tunnel interference vanishes if it is arranged that the reflection of the shock wave from the nose of the model by the tunnel wall will just miss the tail of the model, as shown in Fig. 2. This reflected wave is the first signal indicating the presence of the tunnel wall, and if this reflected wave misses the rear of the model, the tests still simulate motion in an unbounded medium.

Accordingly, a " standard " model was chosen, as shown in Fig. 2, consisting of a 10 deg. half-angle cone at the front, a 4in span tail at the rear, and 16in in overall length. The working section sizes needed at different Mach numbers from 1·4 to 2·5 were calculated, and were turned into pressure ratios against volume flow of air

10,000 H.P. Tunnel Performance

Mach number range	0·3 to about 3·0
Pressure range	Stagnation pressure from 0·2 atmospheres to 1·5 atmospheres absolute, and in certain cases to 2·8 atmospheres absolute
Reynolds number range... ...	From 1×10^6 to 6×10^6 per foot at all Mach numbers above 1·6. Up to 10×10^6 in certain cases
Incidence range	From −6 deg. to +45 deg. at all speeds
Rolling angle range	From 0 deg. to 200 deg. at all speeds
Longitudinal model position...	Model may be placed anywhere in vertical plane of symmetry. No lateral shift of model is provided
Motor horsepower	7700 h.p. continuous and up to 2 hours overload at 10,000 h.p.
Amount of air compressed ...	1·6 tons per minute at atmospheric stagnation pressure and $M=1·9$
Volume flow	59,000 to 200,000 cubic feet per minute. See Fig. 5
Cost of air compressed ...	The air costs 11d. per ton to move past the model at $M=1·9$. Full power costs about £30 per hour for electricity alone



SUPERSONIC WIND TUNNEL

1. Explosion plate.
2. Expansion joint.
3. Cooler.
4. Intake (motor cooling).
5. 10,000 h.p. motor.
6. Gearbox.
7. Swinging elbow.
8. Small compressor.
9. Large compressor.
10. Butterfly valves.
11. 3ft valve.
12. Compressor inlet screen.
13. Safety net.
14. Diffuser.
15. Expansion retraction joint.
16. Control room.
17. Contraction.
18. Screens.
19. Transition.
20. Cascades.

Fig. 1—General arrangement of Mach 3 wind tunnel

by the use of Fig. 4. The curve obtained was called the "minimum air requirement" curve (Fig. 5), and was issued to the compressor manufacturers.

The best compromise between convenience, simplicity and economy, was found to be two centrifugal compressors (Fig. 3) working in parallel to supply a 20in wide working section at Mach numbers up to 1·8, and working in series to supply a 14½in wide working section at Mach numbers above 1·8. The characteristic curves of the Daniel Adamson compressors are shown superimposed in Fig. 5.

The dotted curve, it was explained by the company, shows the wasteful characteristic of a typical axial flow compressor which would handle enough air for the $M=1·4$ condition, and yet have enough compression ratio to drive a Mach number of 2·5. An unnecessarily large volume of air would be compressed at the higher Mach numbers, resulting in higher capital cost and higher operating cost. The single axial compressor does usually result in a fixed working

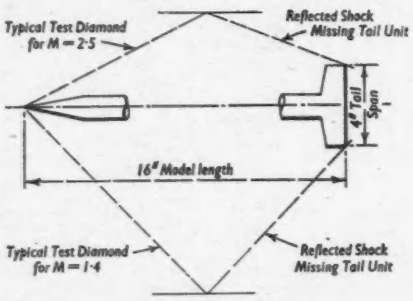

Typical Test Diamond for M = 2·5
Reflected Shock Missing Tail Unit
4" Tail Span
16" Model length
Typical Test Diamond for M = 1·4
Reflected Shock Missing Tail Unit

Fig. 2—Model dimensions for which tunnel was designed

section size and only the throat size varying with Mach number. However, this convenience would have cost another £50,000.

By standardising the 20in (parallel) and 14½in (series) widths of working section, the hinged liners in the balance section between working section and diffuser were found to be reasonably simple to design and manufacture. Similarly, two alternative "adaptors" blend the vertical walls of the contraction smoothly into the two different widths, and at the same time the horizontal walls into the nozzle profiles.

As the nozzles have to be specially designed and manufactured for each Mach number, there is every reason to make the height as great as possible, based on the compressor characteristic curves of Fig. 5. The sizes and Mach numbers adopted are given in the following table :—

Table of Working Section Sizes

Mach number	Width, inches	Height, inches	Assumed pressure ratio	Starting pressure ratio (cold)
0·3 to 1·2 (transonic)	20·0	22·0	1·32 at $M=1$	—
1·25	20·0	24·0	1·45	—
1·4	20·0	24·0	1·55	—
1·55	20·0	20·0	1·75	—
1·7	20·0	19·0	1·94	—
1·9	14·5	19·0	2·22	—
2·1	14·5	19·0	2·50	2·52
2·3	14·5	19·0	2·80	2·90
2·5	14·5	19·0	3·13	3·28
3·0	14·5	16·0	3·93	4·35

Isolation of the Working Section.—The tunnel circuit is filled with dry air, usually at non-atmospheric pressure, and a dewpoint below −25 deg. Cent. has already been maintained. This demands an initial drying period of at least an hour, and it is vital to preserve this dryness during model changes, if delays are to be avoided. A pair of sluice valves were ordered and they cut off the working section at the end of each run, taking one and a half minutes to close (or open). Only the working section is then released to atmosphere, the window swung open, model adjusted, window closed, wet air sucked out, and sluice valves opened again. The whole sequence from supersonic running back to supersonic running can be done in five to ten minutes, without great demands on the air drying and compressing plant, since the main tunnel volume does not have its air pressure changed at all. It has been found that the disadvantages inherent in continuous tunnels have been minimised by this rapid stop and start equipment, and that a large number of useful readings can be taken per hour, no matter whether the test conductor calls for short runs or long runs.

Tunnel Shell.—The tunnel shell is of orthodox fabricated welded steel construction made in sections and bolted together with inset rubber joints. The cooler, elbows, contraction and large end of diffuser are rigidly fixed into reinforced concrete foundations, the remainder being supported on rollers.

Two bellows-type steel expansion joints are installed, the end loads and over-turning moments being reduced by the use of six longitudinal tie rods. An explosion plate is also incorporated in the shell.

The shell is 6ft diameter from the air cooler outlet through the first elbow which contains an elliptical cascade to turn the air through a right angle. This elbow is then connected to a square section elbow by means of a transition enclosed in a cylindrical shell. This construction avoids the use of thick, flat plates, and the cavities so formed are vented to allow the pressure on the inner plates to equalise. The square elbow also contains a rectangular cascade to turn the air again through a right angle into the screen section in which are fitted four fine mesh domed screens mounted in wooden frames spaced 6in apart. The diffuser tapers from 1ft 10½in by 2ft 6in to 6ft 2in diameter where it branches into the two compressor inlets.

Thermal expansion in the diffuser is compensated by a specially designed expansion-retraction joint (shown at 15 in Fig. 1), which can also be compressed by hand-operated screw jacks to create a gap at either end of the working section following the removal of the working section quick release bolts. Bellows type copper expansion joints are provided before the small compressor inlet and at both compressor outlets, one being attached to the swinging elbow. The cooler has a cross section of 8ft by 8ft 3in and contains 6380 ¾in diameter tubes giving a cooling surface of 10,400 square feet and passes 1750 gallons of water per minute.

Other Engineering Details.—The change-over from series to parallel operation at $M=1·8$ demands the swinging of a large pipe elbow, and the operation of a 3ft valve. These items are shown in Fig. 1. It is also necessary to change the small side plates of the balance section to cater for the appropriate working section width. This has been done in four to six hours. Working section changes can, however, be done in less than an hour without disturbing the model. The whole plant is interlocked to prevent starting or running in the absence of cooling water, oil pressure, or with any valves in the wrong positions.

The tunnel will not be run during morning and evening peak periods in the four winter months.

Working Section.—It was decided to avoid the conventional steel box containing replaceable wooden liners. In order to achieve the maximum rigidity, the top and bottom of the working section were machined from iron castings designed as a channel section to the approximate contour of the calculated nozzle with integral cross ribs and end flanges. The contoured surface

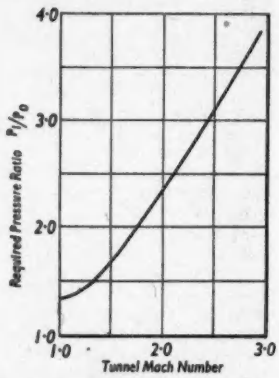


Fig. 4—Curve assumed for pressure ratio to run supersonic tunnel

of these castings, which form the horizontal walls of the working section, was profiled from a cam bar manufactured to accurate limits. A pair of castings is required for every Mach number but the finished cost is comparable with wooden liners, while subsequent shrinkage is eliminated and distortions greatly reduced. The nozzle castings were then bolted between identical steel side plates, the inside faces of which were ground flat. These side plates were fabricated and machined to very fine limits.

However, the windows for flow photography must be opposite the model. Consequently, their leading edge must be ahead of the model. This possible discontinuity in the surface leading

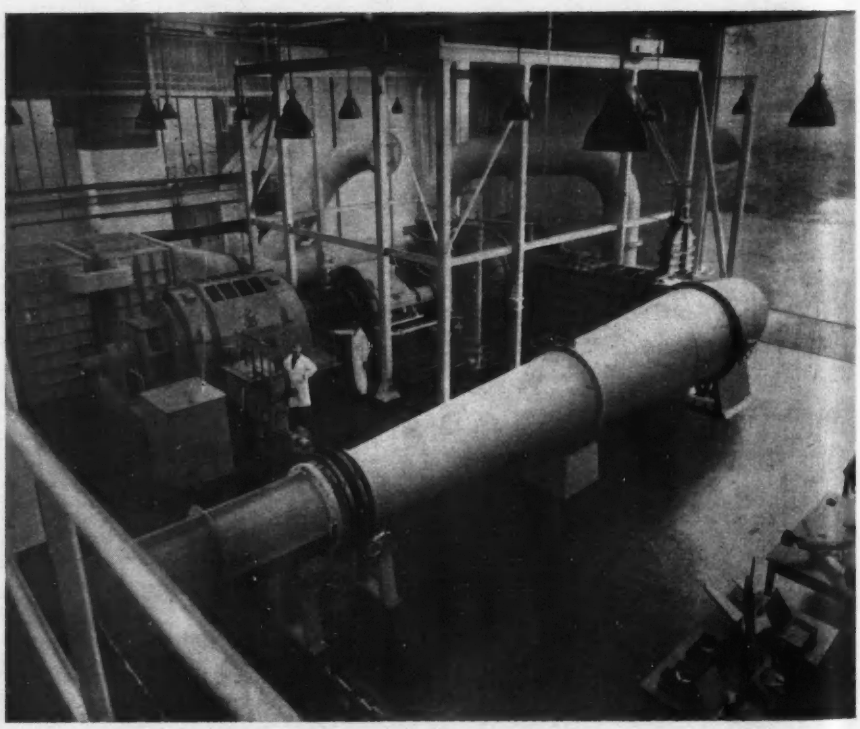


Fig. 3—Driving plant showing 10,000 h.p. motor, gearbox, compressor and cooler

edge of a removable window always presents a difficulty, particularly with circular windows, which give rise to a shock wave of curious shape. One rather cumbersome solution is to remove the whole side of the working section to give access to the model, but it was decided instead to have a rectangular window and frame, the vertical leading edges of which may give rise to a pair of plane crossed shocks in the working section.

Provision has been made to adjust the model longitudinally in the tunnel (see Fig. 8), to enable these shocks to pass harmlessly in front of the nose, and the reflected shock from the walls to clear the tail of the model. A plane shock of small amplitude will not upset the uniformity of Mach number distribution.

The windows are hinged on to the balance section and only the section comprising nozzle blocks and side plates is wheeled out on the trolley when changing Mach number.

Finally, a boundary layer allowance of 0·002in per inch has been provided on all four walls. In the case of the $M=1·9$ working section, provision is made for increasing this allowance on the top and bottom.

Balance Section.—The balance section consists of a rectangular shell with a glass window in the top to be used for yaw measurements. Into this shell are fitted the hinged liners, the vertical ones engaging with the small side plates bolted

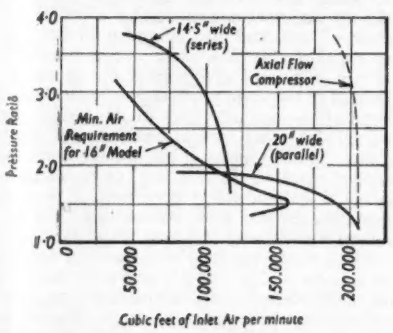


Fig. 5—Comparison of air requirement with air given by compressors

to the balance section shell, a tapered support being fitted between the shell and the liners when set for series working of the compressors. The horizontal liners have interchangeable " slide in " inserts to cater for both widths of working section. They also engage with the ends of the nozzle castings over the range of working section heights. On to the bottom of the balance section is bolted the balance box in which the balance carrying and incidence mechanism is mounted. This box is designed to be easily removable complete with its contents for maintenance and adjustment as necessary.

Incidence Gear and Associated Controls.—The incidence gear consists of two struts carrying the balance and model, keyed together and each driven by an electric motor. A third motor traverses the whole assembly horizontally parallel with the axis of the tunnel. By moving both struts together the model may be raised or lowered, and by moving one relative to the other, the angle of incidence may be changed. Controls are provided whereby an unusually large range of incidence angle (between −6 deg. and +45 deg. in increments of 0·1 deg.) can be selected on a dial, the servo mechanism stopping the gear when the selected incidence has been reached.

The incidence gear control unit ensures that the model rotates about a predetermined point during change of angle of attack. Thus, the incidence gear control unit provides a movement similar to that which might be obtained with a " sector " type gear of variable radius and position. This unit enables the model to be positioned so as to avoid the worst pair of crossed shock-waves in the tunnel. Experience in preliminary trials has already shown that this adjustment is likely to be an essential part of newer tunnels. Large changes of moment are observed when a small shock wave impinges on the conical nose of a body. The readings settle down to a steadier value when the model nose is retracted behind the shock.

Strain Gauge Sting. (*Fig.* 6)—The front end of the model is attached to an internal strain gauge sting, and by measuring bending moments at two stations in perpendicular directions, the normal force, side force, pitching moment and yawing moment can be calculated. These leave rolling moment and drag force to be measured by a separate balance at the rear of the model. To simplify balance design, separate balances have been constructed for roll and drag.

Roll Balance and Associated Controls.—The roll balance consists essentially of a heavy spindle, mounted on ball races and restrained from rotating by a strain gauged cantilever attached at the " fixed " end to a gearbox. The gearbox and spindle are driven by a small electric motor, thus enabling the roll angle to be altered remotely. A combination of pitch and roll will simulate any given combination of incidence and sideslip angles. Rolling moments are measured by the strain gauged cantilever.

The roll balance body houses a potentiometer on which slides a lightly sprung platinum wiper attached to the spindle. This potentiometer, together with the associated roll servo equipment, enables the roll angle to be adjusted remotely over 200 deg. to an accuracy of 0·1 deg., by turning a pointer on the control console to the angle required.

The roll balance incorporates the standard sting taper mounting and fittings brought from the Ordnance Aerophysics Laboratory, Daingerfield, Texas, and is now in use at the Royal Aircraft Establishment and some other tunnels.

Self-Balancing Strain Gauge Equipment.—To avoid trouble due to mains pick-up, this six-channel equipment uses a 625 c/s gauge supply derived from a high stability oscillator. The reading is presented on a circular dial with 100 divisions incorporating a small dial, so that readings to one part in a thousand are obtained without sub-division. The sensitivity or " balance range " is adjustable in six steps, the least sensitive range giving a full-scale reading with 0·6 per cent strain and the most sensitive range 0·01 per cent strain. Each channel incorporates a step repeater transmitter, coupled to a motor in the printer for automatic printing out of results. The sensitivity switches have a similar transmitter mechanically coupled for recording purposes.

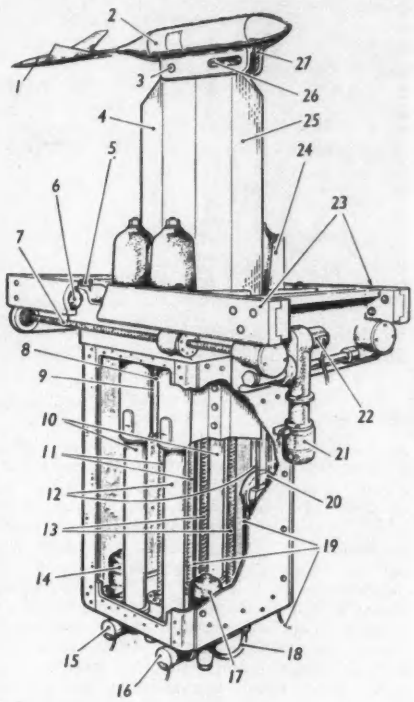
Instrumentation Console (*Fig.* 7).—The essential controls are grouped together, enabling one technician, if necessary, to record the balance readings, to take schlieren and manometer photographs, control the attitude of the model, &c. The dials on the strain gauge units can be read directly, or by pressing a button they can be simultaneously printed in triplicate, together with all other relevant data, by the printing unit housed in a smaller console alongside the balance console.

Printer Recorder Unit.—The unit is operated by pressing a print button, the servo current is cut, freezing the readings. The step repeaters round off the readings to the nearest digit and twenty-two channels are then printed simultaneously, including six strain gauge channels, six sensitivities, roll and incidence angles, both model positions, run number and other channels for date, barometer, stagnation pressure, &c. After printing, the paper is automatically traversed, and the traversing mechanism is arranged to give a wider line spacing, after every five prints, to facilitate reading the printed sheet.

The top carbon sheet is automatically rolled on to a spool to enable the printed results to be observed. A cutter wheel is provided to enable the printed paper roll to be divided into sheets suitable for filing and a selector mechanism is incorporated which warns the operator when any previously determined number of prints has been taken. This helps to prevent the printing of " non-standard " sheets. A shot counter is built into the machine, together with a hand-setting device to facilitate the recording of information which cannot be transmitted automatically.

The pair of 18in diameter mirrors form the basis of an automatic schlieren system. The balance observer can glance at the camera screen, press a button adjacent to the print button, and photograph by spark Schlieren (microsecond duration) the image that he sees. The viewing image is suppressed for a moment during the actual automatic exposing sequence. The Schlieren camera is shown in Fig. 7. Direct shadow pictures can also be taken by obscuring the window and extinguishing the lights. The light source, camera and mirrors can be traversed in a direction parallel with the working section so that pictures can be taken with the model in any longitudinal position.

The pressure plotting manometer has ninety tubes and readings are recorded on an " F24 " aircraft camera which is controlled remotely



1. Model.
2. Strain gauge balance.
3. Front strut fulcrum.
4. Front strut.
5. Guide roller.
6. Horizontal traverse roller.
7. Lead screw horizontal traverse.
8. Potentiometer wiper.
9. Servo potentiometer.
10. Guide bars for vertical traversing of front strut.
11. Front strut lead screws.
12. Guide bars for vertical traversing of rear strut.
13. Rear strut lead screws.
14. Front strut driving motor (driving lead screws through double worm and pinion reduction gear).
15. Front strut transmitter.
16. Rear strut transmitter.
17. Rear strut driving motor.
18. Guide for strain gauge balance cable.
19. Cable to strain gauge balance.
20. Cable tensioner (elastic cord).
21. Horizontal traverse driving motor.
22. Horizontal traverse transmitter.
23. Guide channels for horizontal traverse.
24. Upper anchorage of cable tensioner.
25. Rear strut.
26. Rear strut fulcrum.
27. Cable to strain gauge balance.

Fig. 6—Incidence and traverse mechanism for wind tunnel

from the balance console. The camera incorporates an auxiliary camera for photographing a serial or shot number on the corner of each frame.

Future Instrumentation—Digital Computing.—It is intended to record all the wind tunnel data on five-hole punched tape for reduction in an electronic computer. This means that the strain gauge units, the incidence and roll servo-mechanism, the automatic manometer, &c., will all have to be fitted with digitisers. A single channel has already been fitted with a binary code digitiser designed and manufactured by Sir W. G. Armstrong Whitworth Aircraft, Ltd. This has been connected via a prototype scanning circuit to a relay-actuated tape punch and has proved to be completely satisfactory. It only remains to complete the detail design of the digitisers and to manufacture them to enable tape to be punched and thus have the data rapidly reduced by a digital computer. It is proposed to relay the information by teleprinter landline to such a computer.

Part of the experimental work in a research

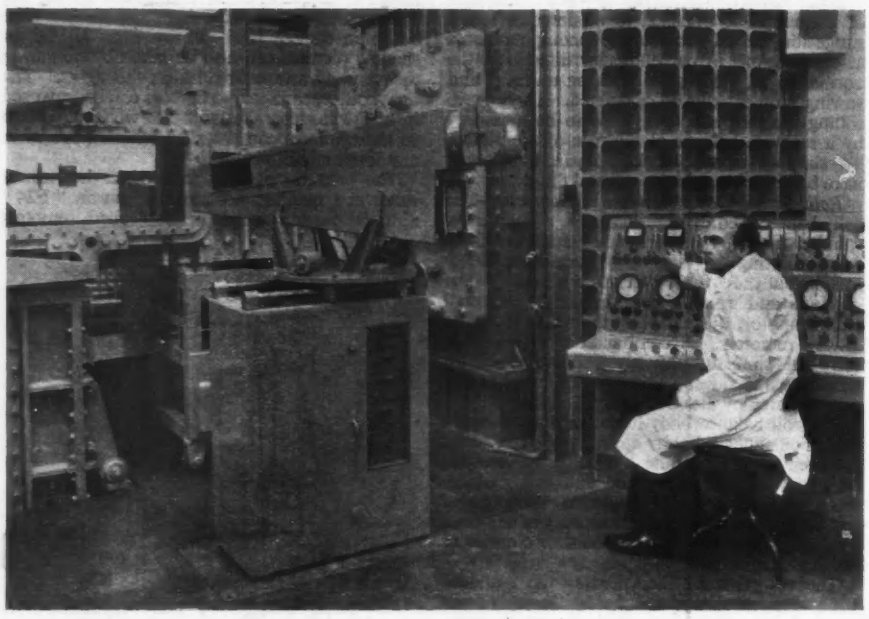


Fig. 7—Control console and Schlieren camera

programme sponsored by the Ministry of Supply is being undertaken by the Wind Tunnel Department. It is hoped to be able to measure the direct and cross complex aerodynamic derivatives which arise on a wing executing rigid body oscillations in pitch, vertical translation and aileron rotation. A considerable amount of instrumentation will have to be developed to enable a wing to be oscillated at frequencies up to 100 c/s and to measure the in-phase and out-of-phase components of the forces on the wing at transonic and supersonic speeds.

It is hoped also to control stagnation pressure by using an automatic manometer having a range of 0in to 90in of mercury in increments of 1/100th of an inch. It incorporates a repeater transmitter for automatic recording on the printing unit.

Air Drying and Compressing Plant.—A 90 h.p. compressor can be used to evacuate the tunnel. Alternatively, it will compress atmospheric air to 100 lb per square inch, and pass it through an activated alumina dryer to the 1700 cubic feet storage vessels. It can then be admitted to the tunnel circuit or working section as required, or used to drive the 10in by 8in intermittent tunnel. The tunnel can be pressurised to 26 lb per square inch in one minute from storage, or evacuated to 1/3 atmosphere in twenty minutes by the pump. Under vacuum conditions, a dry air supply is maintained to labyrinth glands at the end of the compressor shafts to prevent the influx of wet air into the tunnel circuit. Half a pint of water in vapour form is enough to prevent useful operation of the tunnel, due to condensation of fog in the working section, upsetting the temperature, and hence the speed of sound and Mach number. During runs, the 90 h.p. pump is used to recirculate air from the tunnel through the dryer and back into the tunnel again.

Tunnel Performance.—The initial tunnel design had to be based on performance estimates, but now that it is complete the actual performance can be substituted for the design data.

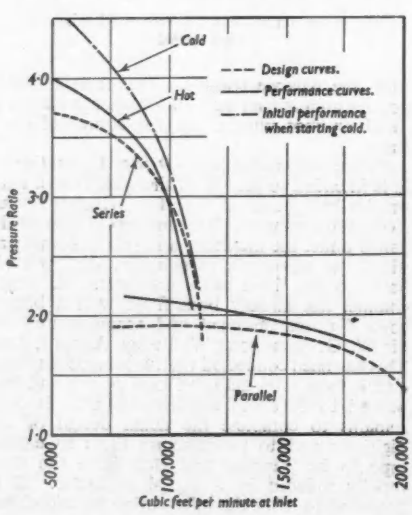


Fig. 8—Compressor characteristics showing design and performance curves

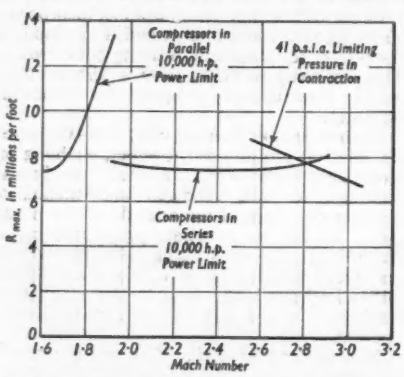


Fig. 9—Maximum attainable Reynolds number predicted from compressor performance curves

In particular, it was found (see Fig. 8) that the main compressors give a higher maximum pressure ratio than was forecast, both in series and in parallel. This has enabled the 19in by 14·5in working section to be run in parallel as well as in series, which will be valuable in minimising change-over from series to parallel compressor configurations.

The higher pressure ratio in series, in round figures 4 : 1 actual, as against 3½ : 1 design, will increase the top speed of the tunnel from $M=2·5$ to $M=3$. In this connection it has been found that a pressure ratio of 4·5 : 1 is available when starting from cold, and this gradually drops back to 4 : 1 as the compressors warm up in the first half-hour of running.

This extra temporary pressure ratio is very useful, as a working section requires more pressure to establish supersonic flow than to maintain it, particularly at Mach numbers above 2·5 or 3. From Fig. 9 it will be seen that this is precisely where the extra initial driving pressure is available.

The efficiency of the compressor set is not as high as had been expected, and this fact coupled with the extra pressure ratio has decreased the air density corresponding to maximum motor power. Thus, the Reynold's number available will be somewhat less than expected, and a curve of maximum available Reynold's number at various Mach numbers is shown in Fig. 9.

It is gratifying, the company explains, to have this extra Mach number range, as the country is critically short of large supersonic tunnels capable of a Mach number of 3. It was anticipated in designing this tunnel that the "thermal barrier" would limit aircraft design speeds to about $M=3$ for some time to come, and the speed range was chosen accordingly.

The principal contractors were as follows; main compressors, Daniel Adamson and Co., Ltd.; main electric motor, Bruce Peebles and Co., Ltd.; gearbox, David Brown and Sons, Ltd.; cooler and tunnel shell, Daniel Adamson and Co., Ltd.; contraction, nozzle and window castings, Revo Foundry Company; switchgear, Allen West, Ltd.

The Inquiring Mind

In collaboration with the British electrical engineering industry the council of the Institution of Electrical Engineers has sponsored the production of a film entitled "The Inquiring Mind," the purpose of which is to encourage more boys from the public and secondary grammar schools to take up electrical engineering as a professional career. Condensed into the thirty-minute showing time of this film there are a number of brilliant sequences giving brief but stimulating glimpses of the variety and scope that a career in electrical engineering offers to the sixteen-year-old boy with a flair for the application of natural science. Some aspects of the profession that are touched upon in the film are the manufacture, testing, installation and operation of plant for generating power and transmitting and controlling it over long distances; the use of electricity to improve amenities and reduce drudgery in the home and in industry where automation is one of the means toward increased productivity; the use of electricity in transport, with particular reference to Britain's programme of railway electrification, and in telecommunications. The boy with the inquiring mind is likely to be interested in research and development, and in some of the questions posed in the film—the problems and prospects of nuclear power, the probability that semi-conductors may largely replace thermionic valves in telecommunications, and the possibility that the photosensitive properties of some of these materials may be used to harness energy from the sun. The film is in black and white, 35mm and 16mm, with sound commentary by Edward Chapman and particulars about its loan may be obtained from the Secretary, the Institution of Electrical Engineers, Savoy Place, London W.C.2.

Books Received

Building Construction. By W. B. McKay. London: Longmans Green and Co., Ltd., 6 and 7, Clifford Street, W.1. Price 45s.

Titanium in Industry. By S. Abkowitz, J. J. Burke and R. H. Hiltz. London: Macmillan and Co., Ltd., St. Martin's Street, W.C.2. Price 36s.

Automatic Feedback Control System Synthesis. By J. G. Truxal. London: McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, E.C.4. Price 89s. 6d.

Water Engineer's Handbook, 1955. Compiled by the staff of *Water and Water Engineering*. Published in London by The Colliery Guardian Co., Ltd., 30 and 31, Furnival Street, Holborn, E.C.4. Price 18s.

Practical Mathematics for Students of Science and Engineering. Volume II. By C. C. T. Baker. London: The English Universities Press, Ltd., Saint Paul's House, Warwick Square, E.C.4. Price 7s. 6d.

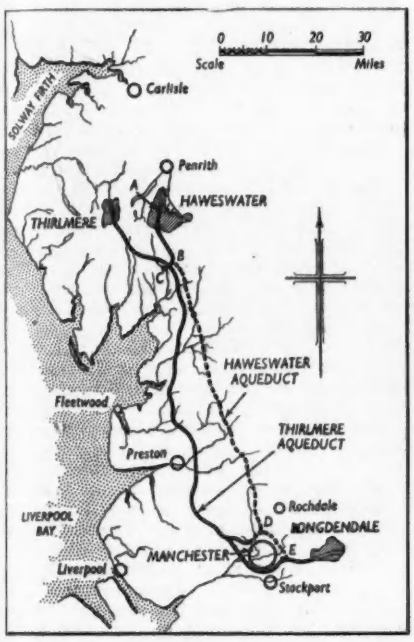
Third International Conference on Hot Dip Galvanising. Held at Oxford, July 4–9, 1954. An edited account of the proceedings at the Conference. Oxford: Zinc Development Association, Lincoln House, Turl Street, Oxford. Price 42s.

Fatigue Tests on Rolled Alloy Steels Made in Electric and Open Hearth Furnaces. By P. H. Frith. Special Report No. 50 of the British Iron and Steel Research Association. London: The Iron and Steel Institute, 4, Grosvenor Gardens, S.W.1. Price, Members, 15s.; non-members, 25s.

Inauguration of Haweswater Aqueduct

ON Tuesday, June 21st, a ceremony was held at Heaton Park reservoir, Manchester, to inaugurate Manchester Corporation Waterworks' Haweswater aqueduct. The inauguration was performed by the Earl of Derby and a commemorative tablet was unveiled at the inlet well house.

The aqueduct is a major civil engineering enterprise, which will carry a maximum quantity of water of 105 million gallons per day. It extends for 82 miles from the storage reservoir at Haweswater, in the Lake District, to the Audenshaw No. 1 reservoir at the Manchester end of the aqueduct, with a connection to the Heaton Park service reservoir, 9 miles before the Audenshaw reservoir is reached. The route followed by the aqueduct is shown in the accompanying map.



Aqueducts for water supply to Manchester showing route of Haweswater aqueduct

Haweswater Water Supply Scheme for Manchester

Total estimated yield (as authorised in 1919) 72 m.g.d. for supply and 9 m.g.d. for compensation water.

First Stage.—Construction of Haweswater dam and reservoir 18,662 m.g. comprising construction of first 9 miles of Haweswater aqueduct between Haweswater reservoir and Garnett Bridge, Longsleddale near Kendal (*A* to *B* on map). Construction of 2½-mile 30in steel pipeline (sprint siphon) forming connecting link into Thirlmere aqueduct (*B* to *C* on map). Stage 1 was brought into use in 1941, and enabled 13 m.g.d. to be sent to Manchester. Microstrainers were added at Garnett Bridge in 1944.

Second Stage.—Construction of main aqueduct and first line of pipes from Garnett Bridge to Audenshaw (*BDE* on map).

Haweswater Aqueduct

	miles
Total length	82
Length in second stage works (*BDE*)	73

Construction:

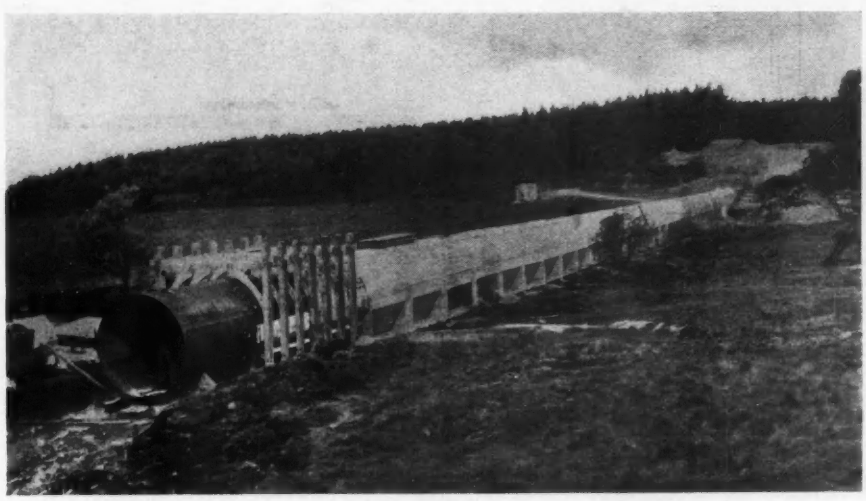
	miles
Concrete lined tunnels (8ft 6in dia)	30·85
"Cut and cover" concrete channels (8ft 6in dia)	7·96
Steel-cored concrete single-pipe siphons (8ft and 7ft 3in dia)	3·84
Steel multi-pipe siphons (normally four lines)	30·34
Steel pipe siphon (Heaton Park to Audenshaw reservoir)	9·20
Total	82·19

Maximum capacity of aqueduct 105 m.g.d.

The aqueduct is built principally in tunnel, but it includes various siphons, pipe-bridges and steel pipe and concrete pipe lengths, as noted in the legend with the map, which gives an idea of the extent of the work. Construction of the second stage works—i.e. all but 9 miles of the entire aqueduct—was started in 1948. Since that time, rock-tunnelling techniques have changed considerably in Great Britain, and various improvements have been introduced. Thus the various tunnels of the aqueduct have in some cases been the proving ground for new tunnel driving and lining techniques; furthermore, unexpected difficulties—such as are inherent in tunnelling work—were met with on occasion, so the tunnelling generally has been of considerable technical interest, and has formed the subject of various papers and articles over the past few years. As one example of a novel use of plant for tunnelling, we refer to an article in THE ENGINEER of October 30, 1953, in which the automatic headgear installed for the construction of Haslingden and Walmersley tunnels was described. The entire second stage scheme was also described in some detail in our issue of June 3rd last.

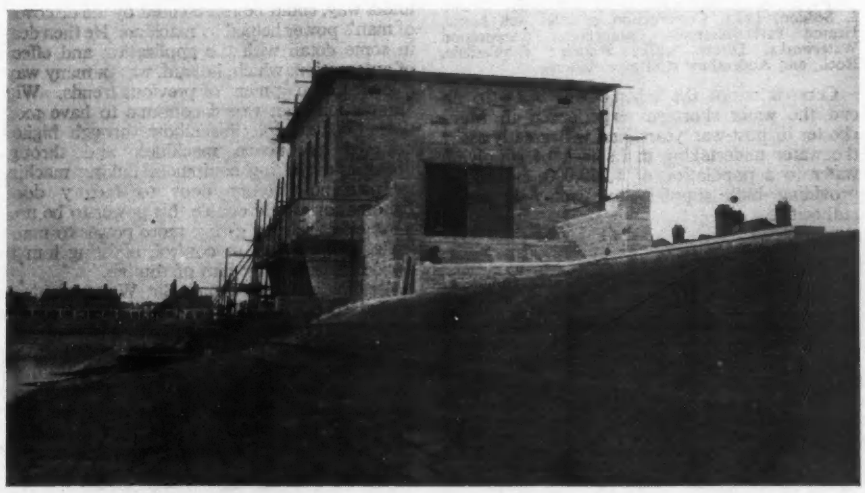
Manchester's water supply is drawn from three sources—Longdendale (19 m.g.d.), Thirlmere (36 m.g.d.) and Haweswater. The Haweswater scheme is of long standing, having first been proposed in 1866. The basic plan of the present scheme was authorised in 1919, and the first stage works, involving construction of the reservoir and a connection to the Thirlmere aqueduct, were started in 1929; the economic difficulties of those times caused delay in construction, and the reservoir was not utilised until 1941. Haweswater dam is of interest as it was the first buttress dam to be built in this country; it has a maximum height of 144ft and a length of 1540ft. A description of its design and construction was printed in THE ENGINEER of February 9, 1940; more recently, a general account of the history of the scheme and of Haweswater dam in particular was given by G. E. Taylor at the Institution of Water Engineers' summer meeting, May 8, 1951.

The reservoir is supplied from natural gathering grounds almost 8000 acres in extent, which will yield almost 36 m.g.d. Its top water level is 790ft O.D. Originally, the scheme envisaged a yield of 72 m.g.d. (plus 9 m.g.d. compensation water) from an area of about 24,000 acres, which has been acquired by the Manchester Corporation. However, the second stage aqueduct was eventually proportioned for a maximum capacity of 105 m.g.d. instead of 81 m.g.d. as originally intended, by increasing the tunnel diameter from 7ft 7in to 8ft 6in. There are in fact ample water supply sources adjacent to Haweswater which can be conveniently added to the 1919 scheme when further augmentation of the supply becomes necessary, and the aqueduct itself is now large enough to meet all foreseeable demands.



Beela siphon carried on piers through a bog. A typical example of steel-cored concrete construction of the aqueduct, in its northern section; the siphon extends from the 16½ to 18 mile points south of Haweswater reservoir. This construction is used where the head in the siphon does not exceed 100ft.

The magnitude of the second stage works fo the Haweswater aqueduct can be judged from their total cost—about £14,000,000. Few, if any, civil engineering schemes of this size have been completed in Great Britain since the war. It will be appreciated that most of the new work is underground, but certain of the surface structures of the aqueduct are shown in

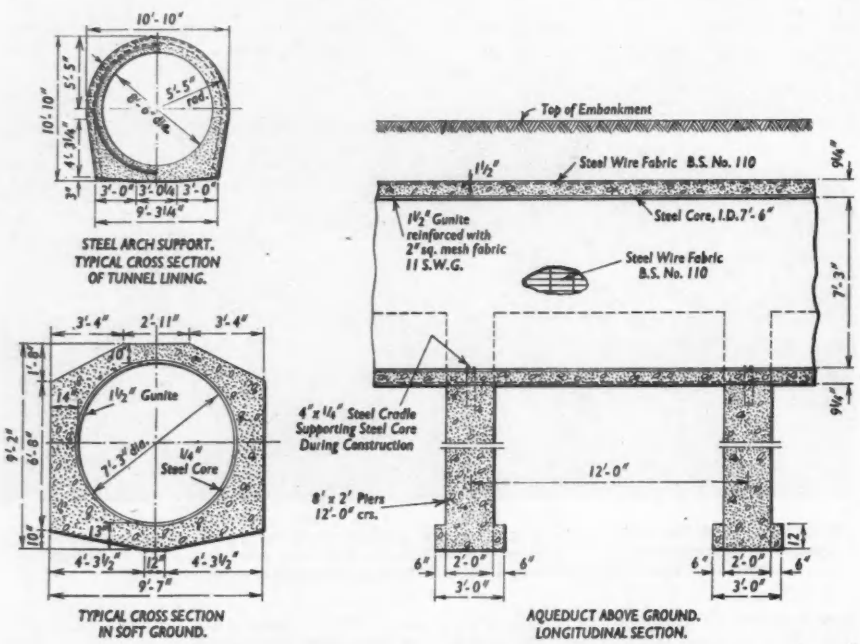


Construction is here shown approaching completion of the inlet well house of Haweswater aqueduct at Heaton Park reservoir

the accompanying illustrations. More detailed technical information about their construction was given, as already mentioned, in our issue of June 3rd, but the typical cross section shown will give a general idea of the kind of construction employed on a very extensive and varied project.

The second stage of the Haweswater scheme, comprising the aqueduct from Garnett Bridge to Audenshaw, has been designed and built under the supervision of the engineering staff of Manchester Corporation Waterworks, under the direction of the engineer and manager Mr. Alan Atkinson, M.I.C.E. The various contractors for the scheme are listed hereunder ;

Edmund Nuttall, Sons and Co. (London), Ltd.: Docker, Coalbank and Hallbank Tunnels ; Watchgate, Park Beck, Beela and Shaw Well single-pipe siphons ; New Hutton, Hallbank, Swarther and Stangana conduits ; Mealbank and Greenbank steel pipe siphons; Bridge over River Mint; H aslingden and Walmersley tunnels. The Cementation Co., Ltd.: Bowland Forest tunnel. A. Waddington and Son, Ltd.: Marl Hill tunnel; Hodder steel-pipe siphon. Earth and General Contracts, Ltd.: Lunesdale steel pipe siphon. Harry Fairclough, Ltd.: Bridges over River Lune and River Ribble. Harry Wimpenny and Sons, Ltd.: Bridges over River Hodder and River Calder. J. Blakeborough and Sons, Ltd.: Supply of automatic valves, air valves, &c. The South Durham Steel and Iron Co., Ltd.: Supply of bitumen-lined and sheathed steel pipes and specials. British Insulated Callender's Construction Co., Ltd.: Supply and laying of electric cables. G. and J. Seddon, Ltd.: Construction of inlet well house, Heaton Park reservoir. Manchester Corporation Waterworks, Direct Works Section : Ribblesdale, Roch, and Audenshaw steel pipe siphons.



Typical cross sections showing some of the kinds of construction used for the Haweswater aqueduct under differing ground conditions

Completion of the scheme will bring to an end the water shortages experienced in Manchester in post-war years, and will greatly assist the water undertaking in its task of supplying water to a population of 1,250,000, as well as providing bulk supplies to twenty-six water authorities.

FURNACE BRICKWORK.—The City and Guilds of London Institute has prepared a two-year part-time final grade course in furnace brickwork, which is intended for journeymen and apprentice bricklayers whose work is largely concerned with refractory and other brickwork in connection with the construction, maintenance and repair of furnaces, kilns and retorts and their ancillary structures. Students entering for the course will normally be expected to have completed successfully the intermediate stage of the Institute's course in brickwork, or a course of equivalent standard. The scheme will come into operation in the college session 1955–56, and the first examination will be held in 1956. Full particulars of the course can be obtained from the City and Guilds of London Institute, Department of Technology, Gresham College, Basinghall Street, London, E.C.2, price 6d.

Conference on the Automatic Factory

THE conference on " The Automatic Factory—What Does it Mean ? " which was organised by the Institution of Production Engineers and held at Margate last week, was attended by more than 850 delegates. In the course of this conference automation, as it is now generally known, was discussed from all angles, including existing applications, equipment for automatic process control now available, the effects the general adoption of automatic control of plant and equipment will have on industries and labour relations, and the challenge the automatic factory presents to technical education.

For his address to the first plenary session of the conference Sir Walter Puckey took for his subject " The Automatic Factory—Dream or Nightmare ? " He first traced the beginning and effects of the first industrial revolution in this country and said that if that was represented by the discovery of machine power then the second industrial revolution, which was already under way, could be represented by the discovery of man's power helped by machine. He then dealt in some detail with the application and effects of automation, which, he said, was in many ways a logical development of previous trends. With automation man would continue to have more power delivered to his elbow through higher-powered productive machines, and through lifting and shifting equipment linking machine to machine, factory door to factory door. Automation would enable this power to be used more effectively by giving more power to man's brain, helping him to control, assisting him to decide and relieving him of routine.

Automation was then, Sir Walter said, a logical successor to other tools placed at our disposal, such as tungsten carbide, fine measuring equipment, T.W.I., work study and material handling equipment. Why, therefore, were we excited and possibly fearful about automation ? Sir Walter believed the main reason was that, while we may accept the idea that a machine should take over our brawn, it was quite another thing to agree that it should take over our brains. He feared nothing in automation that he did not fear now. It seemed logical and inevitable that if we were to achieve a higher standard of life it was necessary to multiply our brawn power, and this surely meant that brains must be utilised more effectively in controlling. Automation, largely through electronic means, brought new and exciting tools to our aid, and production engineers and managers should understand, explain and apply them as a direct contribution to a higher standard of life.

The second plenary session was opened with an address by the Earl of Halsbury on " Technical and Human Problems of the Automatic Factory." He pointed out that a revolutionary technical advance might be due to either of two causes : technical causes and economic causes. The first occurred when a new technical process was found to be possible for the first time ; such advances had occurred recently in the fields of the gas turbine, of the nuclear reactor and of chemotherapy. An advance of the second kind occurred when a technical process which was always possible within the known bounds of Nature's laws became profitable for the first time. The techniques being considered at the conference fell for consideration under both headings : there was in fact no single factor to which one could point and say " This is automation." For this reason many were tempted to deny that the word stood for anything at all.

Historically, said the Earl of Halsbury, automation was coined as a nickname for the work of a development team at the factory of the Ford Motor Company in Detroit. This team was studying the intensive exploitation of what was known in orthodox jargon as " transfer machining." The project was in conception neither original nor epoch making, but its inception represented some clear thinking by Ford's. As the sizes and cutting speeds of machine tools increased the capital charges they contributed to costs grew heavier and the incidence of idle time more onerous. In those circumstances the economic reward to be obtained by mechanically coupling the output of one machine to the input of another became larger in relation to the cost of the coupling. At a critical stage in the development of large fast cutting machine tools a break-even point occurred. Before this point was reached automation was uneconomic ; thereafter it was profitable, and a new technical field presented itself to designers.

The sequel followed a familiar pattern. Designers crowded into the new field and developed everything from fundamental principles to gadgetry ; the power of their method increased, the cost of doing what in the first place barely justified itself, decreased, its scope widened and there was an overflow of technique into adjacent fields. In control engineering terms there was a positive feedback and, said Lord Halsbury, we were at present witnesses to the beginning of such an overflow. Automation as a technique was essential to the industrial well-being of this country in competitive markets, and it could not afford not to exploit it as intensively as possible.

A number of the papers presented before the discussion groups dealt with factory installations and equipment where comprehensive automatic control techniques are already widely used. In his paper " The Automatic Mechanical Project Factory : A Sight of Things to Come," Mr. H. J. Graves described, amongst other machines, automatic transfer machines and conveying equipment in use in the works of the Austin Motor Company, Ltd., and Joseph Lucas, Ltd., and referred to the increased production and the economies made possible by the automation of mechanical processes. In the conclusion to his paper Mr. Graves said, according to some people, that the automatic factory was not a practical proposition, due to its greater complexity, resulting in more frequent breakdowns, which, when they occurred, often stopped the entire manufacturing process. This could largely be overcome by good design and efficient maintenance of machines and tooling.

An answer might be partial automation, where only portions of production would be "automated." Generally, this applied to those operations where manufacturing costs were high and definite benefits would result, or processes where it replaced labour used to perform heavy, arduous and sometimes even dangerous functions, involving considerable operator fatigue. Automation, however, whether partially or fully applied, must be right. The overall results, if properly and intelligently applied, were lower costs, elimination of operator fatigue, greater safety, balanced and increased production, uniform and controlled quality and reduced stocks.

In their paper on "Automatic Linking Devices," Messrs. J. A. Hunt and J. B. Jay dealt with some of the principal criteria governing the design of automatic linking devices and gave some practical examples of their application to plants. It was pointed out that if machines could not be converted and if special machines could not be afforded, it might still be possible by such means as automatic loading machines and inter-machine linking devices to enable one operator to look after two or more machines instead of one.

One of the main objectives of this paper was to suggest that the benefits of automation were neither confined to the "push button" future nor to the great manufacturing organisations.

The simple—sometimes elementary—bases of automation design were demonstrated to show that a step by step or progressive approach could be made in all organisations, large and small, where economic or other considerations invited such an approach. Especially the paper emphasised that, by means of the equipment described, the small manufacturer could gain considerable productivity improvement.

A paper on "Automatic Transfer Machines," by Monsieur P. Bezier, dealt in particular with multi-station machines in which the components remain fixed throughout the sequence of machining operations and are moved from station to station between each stage of machining. He gave details of machines and equipment of this kind in service in the Renault works.

Two papers, "The Computer: Electronics' Contribution to Production," by Mr. R. H. Booth, and "Computer-Controlled Machine Tools," by Mr. D. T. N. Williamson, dealt largely with analogue and digital computing methods, respectively. Mr. Booth's paper is largely reprinted on page 887 of this issue. A further contribution in connection with the application of electronics control for machine tools was a paper by Mr. J. A. Stokes, entitled "Automatic Electronic Control of Machine Tools." This paper dealt largely with work carried out by the B.T.H. Company at Rugby. At the end of this paper Mr. Stokes stressed that if optimum results were to be obtained, a machine tool employing automatic control must be designed throughout with its operating conditions in mind. Automatic controls of any other than the simplest kinds could not be regarded as mere attachments, and the use of this term was to be deprecated for any such installations.

Mr. A. G. Peacock concluded a paper he presented on "Atoms, Electrons and Automation," with the remark that the electronic instrument industry in the past three decades had developed many devices which were automatic in operation and which had been serving reliably in many fields. All the knowledge that had been devoted to the perfection of other successful techniques was available to those who built the automatic factory. It was, therefore, up to the production engineer to come forward with his problems, to meet the electronic engineer and discuss fully with him in a spirit of co-operation how these new tools of modern science could help. But, at the same time, on his side, the electronic engineer must not be completely carried away by the wonder of his own techniques. The great field for electronics was in their application to complicated problems which could not be solved easily by other means. Solutions that demanded simple mechanical devices for their elucidation should not be converted to electronic operation purely for its own sake.

The various aspects and applications of automatic inspection were dealt with by Messrs. J. A. Sargrove and P. Huggins, who pointed out that in an automatic production line automatic inspection between operations was essential to ensure a rational plant layout. The papers read by Mr. F. Garner and Mr. M. Seaman dealt from the administrative angle with problems presented by automation to the manager and to the boardroom. The reactions of trade unions to automation were dealt with in a paper by Mr. E. Fletcher.

Amongst the other papers presented were the following: "The Engineer and the Automatic Factory—A Challenge to the Technical College," by Mr. C. L. Old; "The Engineer and the Automatic Factory—A Challenge to the University," by Professor T. U. Matthew; "The Automatic Factory: The Age of Harmony, Leisure and Plenty?" by Professor Williams; "Automatic Control in the Petroleum Industry—A Case Study," by Mr. I. McCallum; "The Automatic Office—Industry's Electronic Pulse," by Mr. D. W. Hooper; "Precise Materials Handling—A Case Study in Automatic Weighing," by Mr. P. Bourgeois; and "Prerequisites of the Automatic Chemical Factory," by Mr. A. J. Young.

The final paper of the conference was presented by Mr. F. G. Woollard, and was entitled "Machines in the Service of Man." He dealt with the nature, advantages, effects, trends and benefits of automation and concluded by saying that it was necessary always to remember that automation was not a device with which to outlaw, displace or dispense with man. It was not a contrivance nor an invention to deprive man of his heritage—his right to work and to enjoy the fruits of his labours. It was a means for increasing man's stature and for extending his ability to do more and more useful work; to produce in greater volume with less physical effort or mental strain—a means whereby he could bring to his fellows the fulfilment of their lawful desires and, to their homes, comfort and leisure. Men, he said, were not made for machines, but machines were made for man.

Transatlantic Telephone Cable

IT was in December, 1953, that the Postmaster-General signed an agreement with the American Telephone and Telegraph Company, the Canadian Overseas Telecommunications Corporation and the Eastern Telephone and Telegraph Company for the construction of the first transatlantic telephone cable system. This system will replace the radio-telephone, which suffers from fade-outs and the restrictions imposed by the number of wave lengths available, and will provide twenty-nine circuits to the United States and six to Canada from the United Kingdom. All the calls will pass through the International Exchange, London, and one additional circuit will be subdivided into telephone channels to improve the telegraph service to Canada. From Oban, on the west coast of Scotland, there will be 2000 nautical miles of submarine cable linking up with Clarenville, Newfoundland, then 60 miles of overland cable connecting with a further 274 nautical miles of submarine cable to Nova Scotia. Shore stations at Oban, Clarenville, Terrenceville and Sydney Mains will house the terminal and power feeding equipment and from Sydney Mains a 360-mile overland micro-wave system will extend the submarine cable to the United States border and link up with the Bell System network.

Improved design of submarine cable and the development of submerged repeaters have made the project possible. American repeaters, developed by the Bell Telephone Laboratories, will be fitted in the Atlantic section, consisting of two identical cables. The repeaters, which are about 80ft long and will lie at depths up to 2 miles and withstand a pressure of 2½ tons per square inch, will be joined into the cable at intervals of 37 nautical miles, making a total of fifty repeaters in each cable. Between Newfoundland and Nova Scotia a single cable incorporating British repeaters will be laid. These repeaters have directional filters to divide the frequency range of a single cable so that it can be used for transmission in both directions, and are being manufactured by Standard Telephones and Cables, Ltd. It is essential that the amplifying equipment should be trouble-free so that a high degree of perfection in manufacture is required; therefore, the shops concerned in the work use filtered air, are air conditioned and subject to close control of both temperature and humidity. The repeaters, which have about 300 components and have gold deposited on all major internal metal surfaces to inhibit "whiskering," weigh about ¾ ton and are housed in a forged steel case measuring 9ft long by 10½in diameter. They provide the necessary amplification for sixty simultaneous telephone conversations on a two-way basis and the basic units are an amplifier consisting of two amplifiers in parallel, so allowing for the traffic to be carried on in the event of the failure of one; directional filters and bridges for separating out the two directions of transmission; power separating filters which filter out the shore-based power for driving the amplifier from the speech signals; a supervisory unit which, in conjunction with shore-based terminal equipment, can locate any faulty repeater, and equalisers to match the transmission characteristic of the amplifier to that of the submarine cable. Most of the cable is being manufactured by Submarine Cables, Ltd., and is of co-axial pattern having high molecular weight polythene as an insulant. The laying of the cable will be carried out by Her Majesty's Telegraph Ship "Monarch," which has a gross tonnage of 8056 and can carry between 5000 tons and 6000 tons of cable.

At present the "Monarch" is being loaded with 350 nautical miles of cable and in July will lay 217 miles of this cable out to sea from Clarenville, Newfoundland, and buoy the seaward end and then proceed to England for the next phase of the operation. Here the ship will take on board 1130 miles of cable which, together with the remainder of the cable made by the Simplex Wire and Cable Company, and loaded at New Hampshire, U.S.A., will span the deep ocean in one piece from the shore end off Newfoundland to the Rockall Bank, about 500 miles off the coast of Scotland. The remaining part of the cable to join this point with Oban will be laid in September and all the laying operations will be controlled by radio stations, including a chain of Decca navigational stations, to ensure accuracy. American cable terminal equipment is being installed at Clarenville and Oban and this equipment will provide the power needed to operate the valves in the repeaters, 2000V being fed in at each end, positive at one end and negative at the other, and will also adapt the signals received over the cable for transmission over the inland network. A co-axial cable is being laid from Oban to Glasgow as part of the link with London and work is going forward with the laying of the cable, manufactured by Southern United Cables, Ltd., overland from Clarenville to Terrenceville. All of the thirteen micro-wave radio stations in Canada have been built or are under construction and a start has been made on the equipment installation. A similar micro-wave link is being built in the U.S.A. to connect the cable system from the Canadian border to the inland network and for this purpose there will be six stations in Maine.

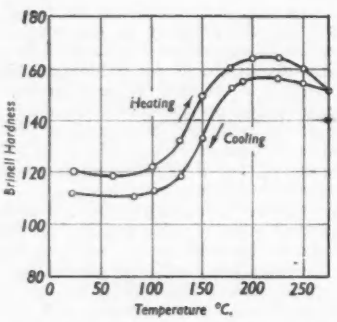
Short Notice

The Testing and Inspection of Engineering Materials. Second edition. By H. E. Davis, G. E. Troxell and C. T. Wiskocil. London: McGraw-Hill Publishing Company, Ltd., 95, Farringdon Street, E.C.4. Price 49s.—The authors of this book are professors of civil engineering at the University of California, and in the preface they state that the full benefits of a course involving the testing of materials are not always attained for various reasons. With this in mind they have endeavoured in this book to provide a general treatment of the principles and problems of testing with specific reference to the mechanical properties of engineering materials, and to establish a basis for their inspection. The subject matter has been arranged in two sections—one giving the general concepts of testing and the other describing methods of conducting common tests.

Metallurgical Topics

Ageing of Mild Steel

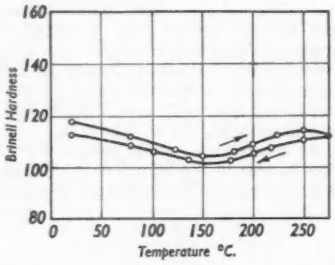
A LARGE number of low-carbon steels having different susceptibilities to ageing have been studied by E. Houdremont, W. Wepner and H. J. Wiester* in order to ascertain whether and to what extent hardness determinations at temperatures up to about 250 deg. Cent. (or to the so-called "blue brittleness" range) would reveal differences in tendency to ageing. The steels investigated included basic Bessemer, a modified basic Bessemer (B. Kalling's process), rimming steels, unkilled, killed and heavily aluminium-killed open-hearth steels, all low and many very low in carbon, and with nitrogen contents varying from 0·003 to 0·021



C 0·04, Si trace, Mn 0·33, P 0·031, S 0·019, N 0·015 per cent

Fig. 1—Hardness-temperature curve of unkilled basic Bessemer steel

per cent. Equipment was devised for rapidly carrying out a succession of Brinell hardness tests on a specimen as it was heated by stages to 290 deg. Cent. and cooled again. The specimens were originally in the normalised condition; the tests were made with a 10mm diameter ball and load of 3000kg, and the load was held for thirty seconds. The hardness/temperature curves for a basic Bessemer steel are shown in Fig. 1, and those for a heavily aluminium-killed open-hearth steel in Fig. 2. Those for other steels were intermediate in type, as indicated in the following table, which shows the average values of the temperature at which the hardness was at



C 0·12, Si 0·15, Mn 0·47, P 0·015, S 0·023, N 0·008, Al 0·058 per cent.

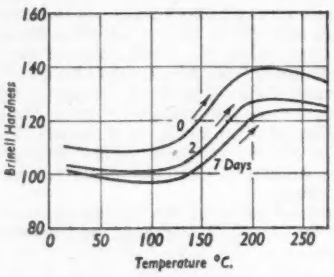
Fig. 2—Hardness-temperature curve of aluminium-killed open-hearth steel

a maximum (T_{max}) and of the difference between this maximum hardness and the hardness at room temperature ($H_{max}-H_{20}$).

Type of steel	T_{max}	$H_{max}-H_{20}$
Basic Bessemer	201	40·0
B. Kalling's modification	200	34·6
Rimming	213	37·5
Rimming	219	34·0
Open-hearth, unkilled	221	29·4
Open-hearth, killed	236	12·4
Open-hearth heavily aluminium-killed	243	−5·0

As shown in Fig. 1, the increased hardness was only observed in tests at the raised temperature, and disappeared on cooling to room temperature. Prolonged heating at temperatures between 200 deg. and 250 deg. Cent. made little difference to the room temperature hardness of the normalised steel, but somewhat reduced the maximum hardness observed at raised temperatures (Fig. 3), indicating on this basis a slight reduction in tendency to ageing.

The increased hardness observed at raised

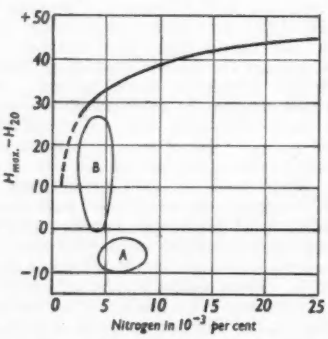


C 0·04, Si trace, Mn 0·44, P 0·029, S 0·017, N 0·007 per cent.

Fig. 3—Hardness-temperature curves of steel as normalised without reheating and after reheating at 250 deg. Cent. for two and seven days

temperatures is due to the fact that the deformation produced by the hardness impression is accompanied instantaneously by rapid ageing. If there is no tendency to ageing, the raised temperature produces no increase in hardness. The series of hardness tests proposed by Houdremont, Wepner and Wiester thus provides a simple means of recognising the tendency of a steel to ageing, and of investigating the effect of composition, hot working or heat-treatment on this tendency.

The increased hardness was found to depend primarily on nitrogen content and to a less extent on the carbon content in so far as these elements were dissolved in the ferrite. The dependence of the hardness increase on the



Aluminium-killed steels do not fall on the curve. Region A: steels with 0·04 to 0·06 per cent aluminium; Region B: steels with 0·012 to 0·024 per cent aluminium.

Fig. 4—Relation between increase in hardness and nitrogen content

nitrogen content is shown in Fig. 4. All the steels fell approximately on an average curve, except the groups indicated, the killed steels being the principal exceptions. The form of the average curve bore out the conclusions of Y. Imai and T. Ishizaki,† who found that in very low carbon steel hardness in the "blue brittleness" range rose rapidly with nitrogen content up to 0·008 per cent and then more slowly. It also supplements the work of W. Hesse,‡ who, a few years ago, made an extensive study based on hardness tests of ageing processes in mild steel after normalising, cooling from 680 deg. Cent. in water, in air or in the furnace, and after cold deformation. He found that in heavily aluminium-killed steel the increase in hardness at raised temperatures did not occur to any appreciable extent, and attributed this to the removal from solution of the nitrogen present in the form of nitride by the aluminium added.

Continuous Casting of Special Steels

IN *La Métallurgie*, May, 1955 (page 361), an illustrated account is given of the first French industrial plant for the continuous casting of special steels.

In 1950, Monsieur Louis Vergniaud, president of the Jacob Holtzer Organisation, faced with the prospect of considerable expenditure on new rolling mills, decided, as an alternative to modernising the blooming mill, to introduce the process of continuous casting for the special steels which were the traditional product of the Holtzer Works. It was realised that continuous casting might probably give a less satisfactory state of the surface than ingots, and that central porosity was likely to be more pronounced in special steels, of which the thermal properties (conductivity, diffusivity, &c.) are generally less favourable than those of ordinary steels.

The first stage in this development was the study of the factors governing success. With this object, liquid steel in a 50 kg container was cast into a copper tube, energetically cooled by the circulation of water. A hydraulic piston closed the lower end of the tube and descended vertically at the same time as metal was being poured in at the top. Experience showed that minute attention to conditions of casting was essential, and especially to two factors of the first importance, speed and temperature of casting. For each type of special steel it was necessary to work out a very precise speed of casting and degree of cooling, if the billet produced was to be free from central unsoundness. In general, temperatures and speeds had to be reduced to the minimum that could be employed without interruption of solidification due to cold metal. Such conditions were opposed to a large output, and it was realised that a plant for continuous casting of special steels could only be productive in augmenting the number of billets cast simultaneously, and this would necessarily lead to an increase in difficulties. This work, involving hundreds of experiments, occupied the best part of two years. However, many preliminary difficulties had been overcome, and encouraging results obtained, and so, in August, 1951, it was decided to continue on a semi-industrial scale.

THE PILOT PLANT

A semi-industrial pilot plant, served by a 300 kg high-frequency furnace supplying liquid steel to a bottom-pouring tundish, was erected. This installation was provided with hydraulic shears to cut the bar and the solidified billet was carried downwards by a system of guide rolls. This plant enabled comparison to be made between continuously cast billets and ingots cast in the ordinary way; and it was by means of this plant that they were able, for the first time, to produce billets of a quality at least equal to, and often better than, that of the ingot, and thus to justify the conviction with which they set out, that the process of continuous casting, applied to special steels, did not necessarily lead to a deterioration of quality but rather to a closer and more rigid control of the conditions of casting. Experimental work with the pilot plant lasted throughout 1952. It produced, at each operation, about 12m of billet of oval section (60mm by 80mm).

INDUSTRIAL INSTALLATION

By March, 1953, an industrial plant yielding 25 tons of billets per day had been installed. The liquid steel from a 1500 kg high-frequency furnace was periodically fed into a tundish, from which the steel was run, either into two moulds simultaneously (section of billet, oval 60mm by 80mm) or into one mould (section 80mm by 105mm). The oval shape was chosen because it gives optimum quality from the point of view of internal soundness. Segregates were not so

* *Archiv Eisenhüttenwesen*, May, 1955, page 279.

† *Science Reports, Tôhoku University*, Series A, December, 1952, Vol. 4, page 553; THE ENGINEER, June 26, 1953, page 894.

‡ *Archiv Eisenhüttenwesen*, 1953, page 173.

localised in oval billets as in those of round or square section, in which segregation tends to accumulate at the centre, thus accentuating central weakness and diminishing transverse properties. The moulds consisted of copper tubes of thickness 4mm to 5mm. The interior was coated by an electrodeposit of hard chromium about 0·1mm in thickness, and the exterior was water cooled. Supplementary cooling of the billet on emerging from the mould was carried out by multiple jets of atomised water. The bars were cut by a 150-ton hydraulic shearing machine. From the lowest part of the installation the bars were carried to the level of the floor of the works by an automatically operated mechanical elevator. The maximum output of the installation is at present 25 tons of special steels a day, with a team of five men.

Quality of the Products

The quality of the products of continuous casting was at least equal to that of material derived from the ingot. In confirmation of this, the paper contains figures taken at random from the records of several classes of special steels and representing the mean of a large number of casts. For example :—

	Tensile strength, tons/sq in	Elongation, per cent	Impact value, mkg/sq cm
Ni-Cr-Mo steel, air cooled and tempered at 200 deg. Cent :			
From continuous casting	128·9	9·0	7·8
From ingot	130·2	8·7	7·0

	Impact value, longitudinal	Mkg/sq cm transverse
Ni-Cr steel, oil-hardened and tempered to 300 Brinell :		
From continuous casting ...	13·5	11·75
From ingot	13·2	11·40
Ni-Cr-Mo steel, oil-hardened and tempered to 300 Brinell :		
From continuous casting ...	12·6	10·4
From ingot	11·8	8·8

Tool steels : curves of endurance against cutting speed were practically identical for 14 per cent tungsten steel and for 18 : 4 : 2 tungsten-chromium-vanadium steel.

Magnet steels : magnetic properties of 6 : 2 chromium-cobalt steel, 15 per cent cobalt and 35 per cent cobalt steels obtained from continuous casting and from ingots were almost identical.

After two years of industrial experience of the process at the Unieux Works, the conclusion was reached that continuous casting of special steels is an economical process. While it is not suggested that it could in the near future supplant the blooming of heavy products, the view is expressed that it is likely to find an important application in the manufacture of highly alloyed steels.

Steel Castings for High-Temperature Service

Steel castings, which must be absolutely reliable at relatively high temperature and stress, are required for high-pressure steam boiler parts and turbine casing. A low-alloy chromium-molybdenum steel is generally used. For example, Sulzer Bros. have made use of cast steel containing carbon 0·13, manganese 0·7, silicon 0·5, chromium 0·5 and molybdenum 0·8 per cent. High-pressure steam equipment is now expected to be in service for longer and longer time ; and this requires materials of higher creep strength and freedom from any danger of premature failure due to embrittlement or notch sensitivity.

Experiments made to improve the steel have been described by W. Siegfried and F. Eisermann* of the Engineering Department of Sulzer Bros. The addition of 0·2 per cent of vanadium to the above-mentioned basis composition resulted in considerable improvement in creep resistance, and the chromium-molybdenum-vanadium steel has been used in high-pressure steam installations. The 1000 hour rupture strength of smooth specimens at 550 deg. Cent. was raised by 0·2 per cent of vanadium from 12·4 to 19·7 tons per square inch, but the steel has been found by laboratory tests to show an increased notch sensitivity, the rupture strength under the same conditions being from 3½ to 4½ tons per square inch lower in notched specimens than in smooth specimens. In an attempt to overcome this defect, an extensive research is being undertaken in the Sulzer Bros. laboratories on the effect of nickel and of copper. A 1850 lb cast of the usual chromium-molybdenum steel was split into twelve parts to each of which additions were made of nickel or copper, or of nickel and copper, with and without vanadium. After being cast into appropriate test pieces, the steels were annealed at 1100 deg. Cent. for five hours and cooled in the furnace. Each was then oil-hardened from 50 deg. above its critical range, and they were all tempered at 720 deg. Cent. for six hours and quenched in water. Creep tests were made at 550 deg. Cent. on smooth and notched specimens. and stress for rupture after 100, 1000, 5000 and 10,000 hours was estimated by interpolation or extrapolation.

In the chromium-molybdenum steel, the 10,000 hour creep rupture strength of the notched specimens exceeded that of the smooth specimens by a margin of about 1½ to 2 tons per square inch. The addition of 0·3 per cent of nickel reversed this order, but with 0·6 or more of nickel the rupture strength of the notched specimen again exceeded that of the smooth specimen. It should be noted that this conclusion applies to steels that had been tempered at a very high temperature (720 deg. Cent.). In steels heat-treated to a high tensile strength, the addition of nickel may possibly increase notch sensitivity.

With reference to copper, a preliminary conclusion (to be verified by further tests) is that copper and nickel have roughly the same effect on notch sensitivity in the high-temperature high-pressure service of these low-alloy steels.

It was found that the tendency towards notch sensitivity shown by the 0·2 per cent vanadium steel was reduced by the addition of 0·2 or 0·3 per cent of nickel, and disappeared completely at higher nickel contents when the notched specimens had a considerably greater rupture strength than the smooth specimens. It appears that minor amounts of nickel and copper may eliminate the tendency to notch sensitivity shown by chromium-molybdenum-vanadium heat-resisting steel.

* *Metal Progress*, April 1955, page 100.

Engineering Applications of Electrodeposition

In a paper contributed to a Symposium on the Structure of Electrodeposits, organised by the Department of Industrial Metallurgy in the University of Birmingham, Mr. R. A. F. Hammond has directed attention to the important engineering applications of electrodeposits. The paper is published in the *Metal Finishing Journal*, May and June, 1955.

The first example of the use of electrodeposition for salvaging worn or undersized components dates back to the 1914–18 war, when a plant was set up behind the lines in France by a British Army unit to repair worn gun parts by the electrodeposition of iron. Iron was later replaced by nickel, and there was a considerable commercial development of nickel deposition for repair purposes in the early 1920s. Since 1925, chromium deposition has been used to produce a hard surface ; and to give high surface hardness and resistance to wear, combined with corrosion resistance, it was found necessary first to deposit nickel and then follow it with a coating of chromium. For purely decorative purposes, the thickness of the nickel and of the chromium need only be 0·001in and 0·00002in, respectively ; but engineering applications may require nickel deposits of 0·25in or more in thickness, though 0·10in is normally regarded as the maximum economically desirable, while the thickness of hard chromium deposits ranges from 0·0001in to 0·01in.

Difficulties and defects associated with heavy deposits are briefly outlined, and as an example of how some of these have been overcome, special mention is made of the insoluble anode process which enables thick and relatively uniform nickel deposits to be obtained in the bores of tubes, 3in or 4in in diameter and 15ft to 20ft long. The anode is of lead or lead-plated steel rod, supported centrally in the tube and isolated from it. The electrolyte (nickel sulphate, sodium sulphate and boric acid) is continuously circulated through the tube from bottom to top. The effluent solution at the top of the tube is passed through a recuperator, in which the periodic addition of a calculated amount of nickel hydroxide powder restores the nickel content of the solution and neutralises the sulphuric acid liberated at the anode. On leaving the regenerator, the solution is filtered and passes back into the circuit.

The first requirement of an electrodeposit for engineering purposes is that it should be strongly adherent to the basis metal ; the second is that it should possess mechanical properties adequate for the purpose intended. To meet the first requirement, special preparatory cleaning treatments are essential, while the second calls for some measure of control over the mechanical properties of the deposit. Under the most favourable conditions, the orientation and crystal structure of the basis metal is continued in the deposit and the two components become virtually one member, resulting in the highest possible degree of adhesion. In general, it is possible to obtain adhesions equal to or greater than the tensile strength of the basis metal.

Material for Condenser Tubes

The chief engineer of the Department of Water and Power of the City of Los Angeles, California, Mr. H. A. Todhunter,* has dealt with problems involved in the selection of material for condenser tubes for the new power station at Los Angeles harbour. In the paper the prevailing water conditions and other factors involved in the design and operation of sea water condensers are discussed. Before a choice of material can be made the quality of the cooling water, the temperature changes through which the water may operate and the water velocity to be used in the tubes must be known.

Before1948 pollution from sewage and organic waste had existed for several years in the water of Los Angeles harbour ; and, while the condition was at its worst, aluminium brass condenser tubes in sea water surface condensers were failing after about one year's service. A campaign to clean up the water in the harbour resulted in the elimination of hydrogen sulphide and anærobic bacteria ; but since then dissolved oxygen has increased and various forms of marine life (objectionable from other points of view) have returned. However, condenser tubes now last for at least five years, compared with one year when pollution was it its worst.

There are considerations to be taken into account, unconnected with the material of the tubes and apart from the obvious design precautions, such as the avoidance of galvanic action at the end supports of the tubes. One of the most important of these is the effect of the cooling water velocity. On the basis of a study made in preparation for the new power plant it was estimated that if tubes operating with a cooling water velocity of 5ft per second would last for about eight years, those with a velocity of 8ft per second would only last five years. Thus the relative cost of cooling water systems to operate at different velocities must also affect the decision.

About 1500 condenser tubes of four types were installed at an existing power station in August, 1947. Their probable compositions are here added to the nominal description given in the paper :—

Admiralty brass	70 : 29 : 1 copper-zinc-tin
Aluminium brass ...	77 : 21 : 2 copper-zinc-aluminium
Aluminium bronze ...	95 : 5 copper-aluminium
Cupro-nickel	70 : 30 copper-nickel

They received cooling water from the Los Angeles inner harbour and the cooling water velocity was 7½ft per second. The rate at which Admiralty brass tubes were failing became excessive after approximately one year's service, after which they were removed from the condenser. Admiralty brass could be expected to give good service in clean sea water at temperatures up to approximately 100 deg. Fah. and for cooling water velocities up to about 5ft per second ; while the other materials mentioned have been developed to give dependable service for higher cooling water velocities. Each has a range of operating conditions for which it can be specially recommended. In the circumstances of the test the order of merit of the other three alloys was aluminium-brass, aluminium-bronze and 70 : 30 cupro-nickel. The cupro-nickel alloy with approximately 0·5 per cent of iron showed the best record of performance, and has been chosen for immediate use. In the harbour steam plant's future sea water installations, 70 : 30 cupro-nickel tubes will most likely be used again and a careful study will be made to determine the optimum quantities and velocities of the cooling water.

* *Corrosion*, May, 1955, page 39.

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AUTOMATION

Automation is a newly-coined word that has come to us from America ; and whether we like the word or not we have got to get used to it ! Yet, strangely enough, this new word expresses something that is not really new at all. The intention is to describe a change in factory procedure. But in reality " automation " is merely the continuation of a trend that has been apparent for at least half-a-century, and which in some existing industries has already been pressed so far that it is difficult to see how it can go much further. Technically the word expresses the concept of the automatic transfer of something undergoing a succession of operations from station to station without human intervention. But there is nothing peculiarly novel about that conception. In food processing industries, for example, the food, received in bulk, is cleaned, sterilised, cooked, divided up into measured portions and canned or wrapped and packaged under hygienic conditions so extreme that far from being touched by human hands it is often not even breathed upon. Where liquids and gases are concerned it is ordinary and obvious practice for the material to flow or be pumped from process to process under automatic control of temperature, pressure, rate of flow and many other factors ; and even for solids examples can be quoted of more or less complete automation as, for example, in the manufacture of domestic electric lamps and in several steelworks' activities. Moreover, a long continued trend in mass-production industries towards the production of special machine tools able simultaneously to perform a number of operations or, alternatively, to perform a succession of operations, amounts clearly to a trend towards what has now quite suddenly been termed " automation." The word has been coined, in fact, not to express an entirely novel concept, but to signalize a particular stage in the orderly evolution of production methods.

But if " automation " means merely the continuance into the future of a long-active evolutionary process, is there any justification for the present excitement about it—that excitement that drew, for example, large numbers of engineers to attend a Conference at Margate on " The Automatic Factory," organised by the Institution of Production Engineers last week ? We think there is. It is indeed not improbable that the excitement is exaggerated. The exciting possibilities are obvious, the limitations of automation have still to be discovered. But the possibly exaggerated attention now being given to automation is quite commonly paralleled in the experience of engineers when some development suddenly promises to telescope a long period of evolution into a short term of years. A similar kind of excitement is to-day shaking engineering firms into aspiring to enter the field of nuclear power engineering. But, curiously enough, the development which has relatively suddenly made it seem reasonable to conceive an automatic factory has little to do with the evolution of transfer machinery or of machine tools. It is the advent of electronics that has made the concept rational. For without the use of electronic devices it would not be possible to control an automatic factory, to feed back information from inspection to machining stations, or to compute how to load the whole in order to attain the highest economic output. Yet electronics is not all. For if electronic control is to replace hand control then it will be necessary to design machine tools—and transfer mechanisms—to suit the characteristics of the control system. That change in design may not prove easy to bring about. Its necessity suggests at least one of the reasons why it would be foolhardy to expect the advent of a fully automatic factory under a term of several years. For the proper mating of the two can only be brought about as experience is gained by the automation of sections of complete factories, the sections chosen being those judged best able to show to good advantage the economies in manpower, floor space, and machine utilisation and the closer control over the accuracy of the product that automation promises.

But automation is not applicable to the manufacture of all engineering products. At least as at present conceived it can only be at all fully applied where outputs are large and specialisation, standardisation and simplification can be pressed very far. The implications for firms producing goods that are more nearly tailor-made—broadly there could be included a large fraction of all the heavier engineering firms in this country and many light engineering firms as well—may well seem rather grim. For the effect of automation, to a much higher degree than of mass-production, is likely to be a cheapening of the product and a heightening of wage rates. Thus, industries in which wages constitute a higher fraction of total costs may find that relatively their costs of production will rise because, to obtain employees, they, too, will have to offer high wages. Yet we refuse to draw gloomy conclusions. There are other factors to be counted in. One of them is that the employees of an automatic factory will not, as now in mass-production factories, be predominantly unskilled or semi-skilled. The demand, as Mr. Woollard stressed at the Conference, will be primarily for men of grades akin to shift engineers in ships or power stations and for first-rate mechanics to service the machines. There will be relatively few unskilled or semi-skilled workers who might draw wages comparable in amount with those earned by skilled men elsewhere. Furthermore, automation is not the only road to economical production. After all, machining is basically a very wasteful process. In machining from the solid bar, for example, as much as 50 per cent or more of the metal is often reduced, at a high expenditure of power, to swarf, fit only for melting down again. That wastage does not apply to processes undergoing rapid development to-day for precision casting and forging. Those processes may in time prove capable of greatly reducing production costs without demanding in exchange either the very large outputs or the very high capital expenditure that full automation entails.

DEFENCE PRIORITIES

" Breeder " reactors and the more plentiful supplies of fissile material now available from new deposits of uranium have made it financially practicable for Britain to develop atomic power for industrial use. As a nation almost wholly dependent on overseas trade, we might, it seems at a first thought, have given first consideration to the application of atomic fuel to merchant ships, so that they could derive benefit from its immense concentration of energy in a small space. Norway, with her adequate supply of hydro-electric power, has indeed already turned her attention to sea-borne reactors. But there seems no good reason why low-powered cargo steamers should install a highly expensive power plant

from which they will obtain no advantage during the periods in harbour loading and unloading cargo. At any rate for this country, which now has to import coal for her industrial requirements, the generation of electricity seems a more profitable employment for atomic fuel at the present time. But different considerations arise in the case of warships, whose operational efficiency, even in these days of fleet trains, is, to a large extent, dependent on fuel. Warships have frequently to proceed at full power for prolonged periods and their design has thus to provide for large fuel carrying capacity at the expense of much-needed equipment, stores and material. To maintain a Task Force at sea requires a continuous stream of tankers, which must be protected in passage—a problem made more difficult by the great disparity in cruising range between the various elements of the Force. An aircraft carrier might well have sufficient endurance for her assignment, but she could not continue without her protecting destroyers.

Apart, moreover, from the fuel difficulty, power plants which do not require a constant supply of air for combustion have special advantages when applied to particular kinds of ships. A large conventionally powered aircraft carrier consumes about 13,000,000 cubic feet of air per hour when steaming at full power. This requires large uptakes and vents within the ship for bringing the air to the boilers, which occupy much valuable space and increase her vulnerability to damage. A still more obvious example is the submarine, whose performance submerged has hitherto been severely restricted by the need for air. The fitting of the snort was nothing more than a temporary expedient to enable her to charge her batteries when submerged and to make passages submerged at a maximum speed of 10 knots. The snort has in any event lost much of its value as a result of the improvements in radar. The Americans seem satisfied that a nuclear plant is a satisfactory answer to the problem and, if Congress approves the naval construction asked for in the current year's programme, the United States Navy will soon have a flotilla of seven submarines with atomic power plants. As might have been expected, however, these submarines are very large—over 3000 tons—and thus likely to be unhandy submerged and an easy target for asdics. The Royal Navy is investigating an entirely different solution and has two submarines now being completed with propulsive machinery using hydrogen peroxide. No further information has been issued about their engines, but it seems likely they are based on the closed cycle engine the Germans were installing in their new submarines being built at the end of the war, for which hydrogen peroxide was to be used as oxydant. According to reliable German sources, these new submarines were to have had an endurance submerged of 158 miles at 25 knots and about 280 miles at 15 knots, which would have given a performance submerged adequate to meet all likely operational requirements.

But Britain has more urgent defence requirements than to build warships with power plants which greatly increase their cost. The Royal Navy needs more heavy carriers—each costing at least £10,000,000 with a conventional plant—if it is to carry out the tasks laid down in the Defence White Paper. This country is also very much behindhand with anti-aircraft defences, ashore, afloat and in the air. No aircraft squadrons are at present equipped with air-to-air guided missiles and the first sign of a ground or surface-to-air missile is the ship-to-air missile, to be tested by the Royal Navy next year. Yet the United States is erecting ground-to-air batteries for the defence of her cities ; in addition to her Air Force fighters, nine U.S. carriers have squadrons equipped to fire air-to-air missiles ; and two U.S. heavy cruisers are shortly to rejoin the Fleet with their anti-aircraft armament converted to guided missile firing. In our own interests and in the interests of N.A.T.O. it seems essential to give more priority to the production of guided missiles even if this results in fewer bombers to act as a deterrent force or as a counter offensive. To leave the deterrent entirely in United States hands might well deprive this country of any effective voice in determining when to use thermo-nuclear weapons and which targets to select. But in a war which, as the recent Defence White Paper emphasised, would be a struggle for survival of the grimmest kind, some consideration should be given to the fact that the strength of the existing deterrent force is already immense. One of the three U.S. factories manufacturing the six-jet B47 bomber produced 1000 of these machines before the end of the last year and to these must be added the vast number of B-36s and the still more modern B-52s which now form part of the U.S. Strategic Air Force. Measures which will help to keep this country in action seem no less essential than adding to the strength of a force already adequate.

Obituary

DR.-ING. ERNST FOERSTER

It is with deep regret that we have to record the death recently of Dr.-Ing Ernst Foerster, the joint publisher and chief editor of *Schiff und Hafen*, Hamburg. Dr. Foerster was in his seventy-ninth year. Happily, he was able to carry on his many-sided work almost to the last. He studied naval architecture and marine engineering at the Technical High School, Charlottenburg and, after completing his course, he joined the firm of Blohm and Voss, of Hamburg, and for nine years worked as naval architect and later as marine engineer on commercial ship construction. He was closely connected and responsible for the design and construction of the hull and machinery of the " Vaterland."

On leaving Blohm and Voss, Dr. Foerster joined the Hamburg-Amerika Line, and took charge of the ship construction department of the firm for over eight years. In 1920 he resigned from the Hamburg-Amerika Line in order to become an independent consulting engineer, but he retained his position as permanent technical adviser to the Hapag for many years. During this time he took a keen interest in the facilities for ship tank testing work in Hamburg and he formulated plans for the construction of the Hamburg tank. In 1920 he also became chief editor of the technical journal *Werft-Reederei-Hafen*, which had been founded by the Springer publishing firm. His close connection with the shipbuilding industry and the shipping firms enabled him to carry on the paper with great success until 1945, when conditions after the second world war forced it to close down. He found time to re-edit the " Hilfsbuch für den Schiffbau," by von Johow, and also to write his own book on practical shipbuilding. When the construction of the Hamburg testing tank of the Hamburgische Schiffbau-Versuchsanstalt was begun following the closing of the Bremen tank, when the Bremen harbour was rebuilt, Dr. Foerster took a personal interest in its work and was on the board of the tank for some twenty years. He it was who founded " The Society of Friends and Supporters of the Hamburg Tank," which had a wide membership in all parts of Europe, and did much to provide means for research and work for the tank. This Society had to be disbanded after the second world war but he revived it in recent years.

An interesting feature of the work of the Society was the series of summer and autumn meetings held in ships such as the " Monte Rosa " and " Monte Pascoal," which made short voyages to other countries. In this way England, Scotland, Scandinavia and European countries were visited, bringing friends together and seeing important shipbuilding centres. Dr. Foerster was a member of the Verein Deutscher Ingenieure for over fifty years and took a keen interest in the work of the Hamburg branch. In recent years he gave several lectures on various aspects of German shipbuilding and marine engineering. He also belonged to the Schiffbautechnischen Gesellschaft and for close on fifty years he worked with it. He was also a member of the Institution of Naval Architects for many years. His editorial and international work suffered from the aftermath of the 1945 war but he did not lose courage and in 1949, together with Professor Dr.-Ing Schnadel, he founded the journal *Schiff und Hafen*. His outstanding work for the shipbuilding and shipping industries of his own country will long be remembered, and he will be sorely missed by many friends in many countries.

Technical Authorship

In September next, the Coventry College of Art is to institute a course in technical authorship and illustrating. Last Saturday, a conference, convened at the request of the Technical Publications Association, was held at Coventry to study the syllabus for the course which has been prepared by Mr. James Wilson, personnel training officer of the Standard Motor Company, Ltd. At this conference it was pointed out that the ever-increasing complexity of modern engineering products had created a demand for technical authors. The course at Coventry is being inaugurated because of the difficulty experienced by engineering organisations in recruiting trained personnel for the preparation of handbooks and other technical literature. The course provides for sixty hours' instruction, spread over ten weeks, on Saturday mornings and two evenings. The lectures will cover such matters as the technique of writing and publication planning, letterpress printing and the reproduction of illustrations, collaboration between authors and illustrators, and editorial work. During the conference last Saturday it was stated that courses in technical illustrating had been running at the Coventry College of Art for nearly a year, and that the City and Guilds of London Institute had been approached with a view to the establishment of a national certificate examination in that subject. It was felt, however, that a national diploma for technical authorship should be instituted. A committee was therefore formed to consider an approach to the Minister of Education concerning the establishment of a diploma examination.

Extensions to the Willoughby Lane Gas Works, Tottenham

Extensions to the Willoughby Lane Gas Works of the Eastern Gas Board at Tottenham have involved the construction of a new continuous vertical retort house capable of producing 8,000,000 cubic feet of gas a day, a new carbonising plant, and a producer gas dilution plant. A large new conveyor system has been laid down to serve the plant, and the carbonising plant is not enclosed but protected by roof only.

A COMPREHENSIVE extension scheme was recently completed at the Willoughby Lane gas works at Tottenham by the Eastern Gas Board. The decision to carry out these extensions was made by the former Tottenham and District Gas Company shortly before Vesting Date. The continuous vertical retort house, built in 1916, with mechanical producers, and rebuilt in 1928 with "built-in" producers, had given excellent service, but the mechanical handling plant was in such a condition that extensive renewals were due. By modern standards the working conditions at the plant were most restricted, and it was decided that in preference to rebuilding the plant in its existing house, it should be entirely replaced by a larger installation capable of producing 8,000,000 cubic feet of gas per day at 500 B.Th.U. per cubic foot.

In addition to the new carbonising plant, a producer gas dilution plant of 2,000,000 cubic feet per day capacity will be erected this year. This dilution with the aid of increased calorific values in the carburetted water gas plant will enable additional gas to be manufactured at times of peak demand. A benzol extraction plant, which is due for extension, is capable of effecting a maximum reduction in the calorific value of the gas of only 13 B.Th.U. per cubic foot. The declared calorific value is 490 B.Th.U. per cubic foot.

The new coal handling plant installed at the works is designed to deal with the existing intermittent vertical chambers as well as the new continuous vertical retorts and a further extension of vertical retorts of equal capacity. The coal carbonised by these three plants would total some 1500 tons a day. The sidings provided hold 440 wagons, and there are double-ended reception roads permitting trains of up to eighty wagons to be run in direct from the railway. The unloading plant has been designed to deal with all the coal required for carbonising, together with an equal quantity for stocking, during the normal working hours of a five-day week. This is achieved by employing two combined wagon tipplers and weighers, each of which can handle twenty wagons per hour. Wagons pushed from the tippler run to the "empties" sidings by gravity.

Coal is elevated to the main crushers by belt conveyors and raised by further belts for discharge into storage silos. Each of the two parallel elevating systems installed handles a maximum of 240 tons per hour, and there are three storage silos, each of 600 tons capacity, with provision for a fourth. These silos are arranged to store coal for blending; to act as buffers between the high-speed unloading of wagons carried out during daylight hours, and the slower passage of coal to the carbonising plant or to store; to provide storage to avoid week-end and Bank Holiday working, and to facilitate the immediate clearance of coal trains as they arrive. The three silos contain clean Yorkshire or East Midland coals for the continuous vertical retorts; Durham coals for the intermittent vertical chambers, and low swelling coals and coals of high shale content, to be blended with Durhams, for carbonising in the intermittent vertical chambers.

Blending is effected by feeding on to belt conveyors through adjustable vibrating feeders, and all coal blended for the intermittent vertical chamber house passes on its way to the plant through a crusher which reduces it to a ¼in size. Coal is taken to the retort houses by inclined band conveyors and distributed to the overhead hoppers by push plate conveyors. Belt weighers are provided on the conveyors feeding coal to each retort house. The storage capacity in the retort house bunkers amounts to two days' supply in the case of the intermittent vertical chamber plant and three days in the case of the continuous vertical retort plant.

The coal stocking ground holds 52,000 tons of coal stacked to a depth of 18ft and is served by a travelling "Goliath" crane having a 2½-ton capacity grab. Coal can be delivered from any of the silos at a rate of 100 tons per hour and passed to the stocking ground by a band conveyor. The coal is discharged from the conveyor into a sunken bay adjacent to and running the full length of the western side of the coal heap. The coal is subsequently moved transversely into the heap by the transporter at a convenient time. Coal raised from stock is loaded by the transporter on to a belt on the eastern side of the stocking ground and may be returned to the silos also at a rate of 100 tons per hour. The whole of the work involved in the stocking and reclaiming of coal is carried out by one man, the transporter driver.

The works are planned to produce the maximum quantity of high-grade continuous vertical retort coke for sale on the domestic market. To achieve this, two special provisions have been made: the continuous vertical retort producers are fed with intermittent vertical chamber coke; and undesirable Yorkshire and East Midland coals can be disposed of as already described, by blending in the intermittent vertical chamber plant.

In the continuous vertical plant duplicated band conveyors, running beneath the retort extractor boxes, convey the discharged coke from the north and south benches to a central position. Here, two further duplicated conveyors, running in a subway beneath the boiler house and power house, convey the coke to the base of a transfer tower, whence it is conveyed to the screening plant. The duplication ensures continuity in the handling of discharged coke in the event of a breakdown of, or repairs to, any one of the conveyors. The operating rate is 35 tons per hour.

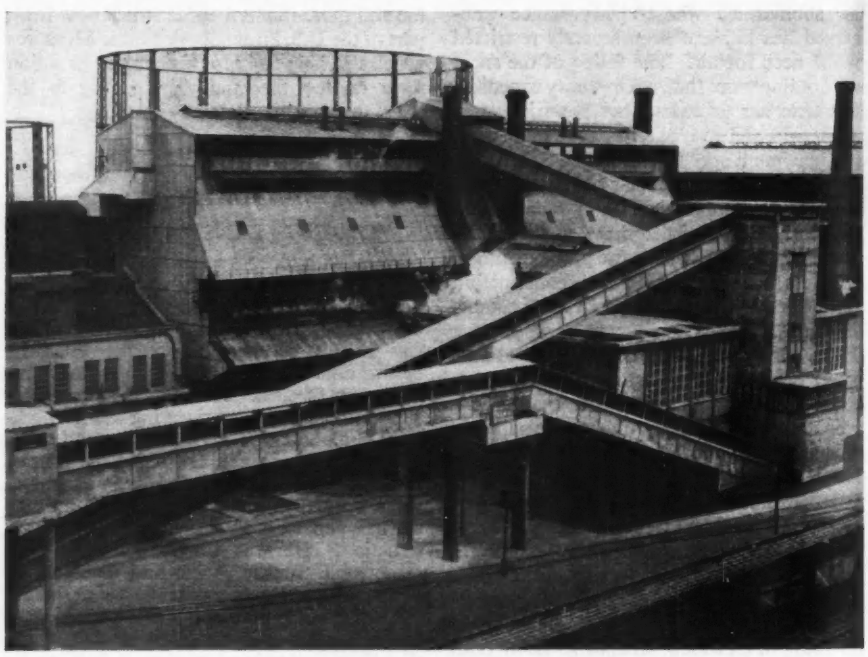
The coke screening plant consists of duplicated vibrating screens, grading into the three recognised sizes and breeze. There are nine coke hoppers, four for each of the two sets of screens, and the total capacity of the hoppers is 730 tons. Coke from the continuous vertical retort house may be put to stock by the use of a chain of electrically interlinked portable conveyors fed from a discharge point on the conveyor leading to the screens. The same portable conveyor installation is used to reclaim coke from stock by feeding into a recovery point on the conveyor system. The coke stocking ground has a capacity of 26,000 tons.

Coke is stocked ungraded but as each set of screens is capable of dealing with the whole output, the quantity available for sale can be doubled at times of peak demand by bringing both sets of screens into action, and feeding them with coke from stock.

The coke from the intermittent vertical chambers is screened in the existing screening plant into appropriate sizes and is distributed by belt conveyors to the intermittent vertical chamber producers and to the intermittent vertical chamber breeze pads, the continuous vertical retort producers, and to the carburetted water gas plant. The coke enters the continuous vertical retort house above storage hopper level, and is distributed to the north and south producer hoppers by a reversible belt conveyor. This same conveyor is used for delivering coke to the carburetted water gas plant, which is situated in a building adjacent to and in line with the continuous vertical retort settings. Belt weighers are provided on each of the conveyors taking coke from the continuous vertical retort house and on the conveyor taking coke to the carburetted water gas plant.

It was originally intended that the conveyor gantries should be steel framed, supported on reinforced concrete trestles and towers. As a result of difficulties in steel supplies, however, it was decided to build the gantries in prestressed concrete. This, in addition to reducing the steel requirements by 500 tons, has resulted in a durable structure needing little maintenance. The capital cost was about 15 per cent more than the estimated cost of the steel-framed design, but this is more then offset by lower maintenance costs.

Each gantry consists of two prestressed girders of 6ft 6in deep, with reinforced concrete floor decking and roof framing to form a box



Retort installation, power house and conveyors

section. The girders were cast-in-situ and post-tensioned by the Magnel Blaton system. The majority of the spans are 90ft long. Each gantry is supported by sliding bearings at one end and with fixed supports at the other end. The gantry over the British Railways' property is continuous in spans of 72ft and 108ft.

Control of the Handling Plant

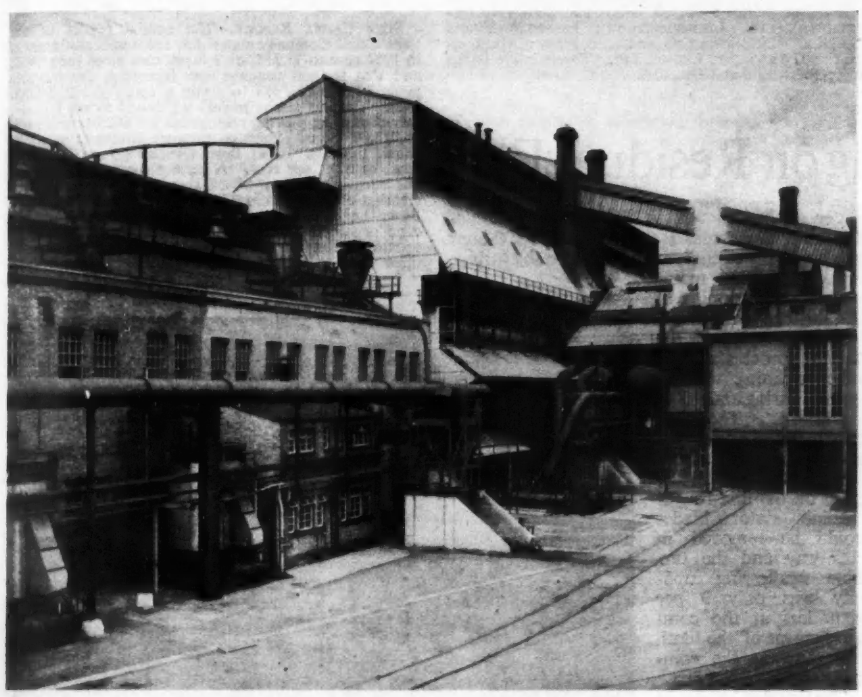
The electrical plant of the coal and coke conveyors is divided into the following sections, each of which comprises three or more electrically interlocked flow sequences :—

(i) Coal from wagon tipplers and from stock to the storage silos ;

(ii) Coal from the storage silos to the retort houses and to stock ;

(iii) Coke from the continuous vertical retorts to the coke grading plant and to stock ; and

(iv) Coke from the intermittent vertical chamber coke plant to the retort houses and carburetted water gas plant.



Retort installation and waste heat boiler house

The conveyors carrying coke from the intermittent vertical chamber coke plant to the continuous vertical retorts and to the carburetted water gas plant are fully automatic in operation, the flow being controlled by bunker level electrodes. Further, the size of coke is selected by push-button control at the coke plant, according to the particular bunker to which it is being despatched.

The control gear for each of the four sections is grouped in positions most convenient for the operator concerned, and with the exception of section (i), mimic diagrams are provided to indicate the sequence in operation. Direct on-line starting has been adopted for all conveyor drives. Electronic metal detectors are installed on the belts from the wagon tipplers to the coal crushers and when metal is detected an alarm is set off and the belt is stopped automatically.

Carbonising Plant

There are sixty-four 82in continuous vertical retorts, arranged in four benches, each of four sections of four retorts, the benches being in one straight line. Gaps are left between the four benches, but the space between the second and third benches is larger, and since coal, coke and waste gases enter or leave at this centre section the settings may be considered to consist of a northern and a southern half. Heating is by means of the " lambent heating " system, there being twelve external step grate producers arranged in four groups of three. The two groups in the north and the two in the south feed into common north and south producer gas mains. Intermittent vertical chamber coke is fed to the producers through automatic weighers.

A dust collecting system is installed with hoods adjacent to the opening of each extractor box to deal with dust released during coke discharging. The valves between the hoods and the collecting duct of the system which runs between the extractor boxes are automatically operated by cams on the coke discharge car. Dust is extracted from the system, passes through water filters and is discharged as a sludge. Two steel, fire-brick-lined waste gas flues run from the north and south pairs of benches to the centre of the settings, from which the waste gases may pass to their respective chimneys or to the waste heat boilers.

Willoughby Lane Works is not situated in a residential area, and as, in any case, there is no architectural merit in disguising an industrial plant of this nature, the orthodox retort house building has been dispensed with. No walls are provided and protection from the weather is afforded by a series of " umbrella " roofs. This method of construction showed substantial saving in capital cost and has given improved working conditions on the settings.

The tar and liquor system has been designed to relieve, so far as is economically possible, the difficulties of the disposal of effluent from the Board's chemical works after the manufacture of sulphate of ammonia. Use is made of heavy spraying, rapid separation of tar and liquor, and segregation of retort house liquor, although the use of hot gas detarrers has not been considered justifiable.

The normal retort house separators are used with the addition of measuring compartments, which regulate the quantity of retort house liquor bled off with the tar run-off. This liquor is led to a separate compartment in the main separator and is at present used, after cooling, in the final gas bays of the static washers. This avoids the use of water at most times of the year and enables a stronger final mixed liquor to be produced. The ultimate aim is to dispose of this retort house liquor separately when a suitable process is devised for its treatment.

The main reinforced concrete separator tank consists of three compartments, one for the retort house liquor, a central compartment for tar, and a third for condenser liquor. The tar and liquor pumps, all of which are electrically driven, are mounted on top of the tank, whilst the condensers are mounted on a reinforced concrete platform immediately above the pumps.

The overflow from the condenser liquor side of the main separator is passed to a 70,000-gallon weak liquor tank, where final separation of small quantities of tar takes place. The liquor is then strengthened by being used as the washing medium in the earlier gas bays of the static washers. The strong liquors from the washers flow to the main works storage.

The waste heat boilers, as can be seen from one of our illustrations, are not housed in an orthodox building, but, as with the retort settings, are provided with an umbrella roof giving good air circulation and cooler working conditions. Three boilers are installed, one operating for each half of the settings and the third is a common standby. The boilers generate steam at 275 lb per square inch superheated by 200 deg. Fah. Feed water for these boilers is obtained from the existing base exchange softener and is acidified to release the carbon dioxide, which is then removed in an air-blown tower. The water is finally deaerated before passing to the boilers. The boiler feed pumps are operated by steam at 120 lb per square inch from the main works supply and the exhaust steam from the pumps is used for feed water heating.

The steam supply from the waste heat boilers is used in the generation of electric power. The engines driving the generators exhaust at 30 lb per square inch and the exhaust steam is used on the settings of both retort houses, for benzol extraction and for other processes.

Prior to the inception of the new plant, power requirements were met by an internally generated direct current supply, except that alternating current, from the public supply mains, was used for the carburetted water gas plant, the chemical works and for deep well pumps. With the exception of plant unsuitable for conversion, the whole works now operate on alternating current. The maximum requirements are about 700kW. Two out of the three 300kW continuously rated steam-engine-driven alternators are run at a time, and together absorb the total output of 18,800 lb of steam per hour from the waster heat boilers.

The engines driving the generators are fitted with specially designed governor gear, which maintains the maximum output consistent with the steam available. Electric power is generated at 415V, 3 phase, and is distributed from the power house to the greater part of the works at this voltage. For transmission to the coal unloading plant it is stepped up to 11,000V and transformed down again on the east side of the railway. The 11,000V system is linked with the public supply mains and any balance of power requirement is made up from this source.

The main low tension control board has draw-out truck design air break switchgear and eight radial feeders from this board are divided into two sections, one serving essential and the other non-essential plants. A reverse power relay on the incoming transformer equipment ensures that, in the event of a public supply failure, the incoming switch is opened and the non-essential feeders are disconnected from the busbars. Capacitors are provided to raise automatically the power factor of the works load to an economical level.

Purification Plant

The three vertical water tube condensers, each of 4·2 million cubic feet a day capacity, have common inlet and outlet mains, with suitable valves for individual operation, and are normally operated in parallel. Each condenser is divided into a primary and secondary section, with circulated water on the primary section and water from the works own well on the secondary section. The well water is subsequently used for circulating water make-up. In order to provide a gravity return for the circulating water from the condensers to the cooling tower, which is situated on the other side of the railway line, the condensers are mounted on an elevated platform. The tar and liquor separator is housed in the base of this structure.

Two " Connersville " exhausters, driven by vertical twin-cylinder engines are installed, with provision for a third set. Each of these exhausters has a capacity of 9·6 million cubic

feet a day. Two electrostatic detarrers, each of 9,000,000 cubic feet a day capacity, have been installed and either is capable of dealing with the total output. Three four-chamber, "Multifilm" static washers, each of 9,000,000 cubic feet a day capacity are operated in series and any two of the washers when working together in series are sufficient to give adequate washing.

The oxide purifiers are elevated boxes of reinforced concrete and consist of four sections of five boxes arranged in two lines. Each box is 30ft square, 7ft deep, and contains two 2ft 3in layers of oxide. An overhead transporter spans the two lines of boxes and carries a 25 tons per hour conveyor for filling the boxes. New carburetted water gas purifiers of similar design, but consisting of four sections of four boxes, have been built in line with the continuous vertical retort purifiers, and are served by the same travelling transporter. Meters of the "Connersville" type, each of 2·4 million cubic feet a day capacity, are located in a central position beneath the purifiers, there being one meter to each section of the purifiers, and attached to each meter is a rate of flow indicator which enables the four gas streams to be balanced.

The general planning of the extensions was undertaken by the Board's Engineering staff, which carried out the design of the coal and coke handling plant, power house, purifiers, electrical installations.

Amongst the main contractors employed were the following firms :—

Carbonising plant : The Woodall-Duckham Construction Co., Ltd. Coal and coke handling plant foundations and concrete structures : Peter Lind and Co., Ltd. Belt conveyors : Hugh Wood and Co., Ltd. Wagon tipplers : Fraser and Chalmers, Ltd. Road weighbridge : W. and T. Avery, Ltd. Coal crushers : British Jeffrey-Diamond, Ltd. Transporter : Babcock and Wilcox, Ltd. Coke screens : Robert Cort and Son, Ltd. Debreezing screens : A.C.E. Machinery, Ltd. Feeders and debreezing screens : Lockers (Engineers), Ltd. Portable conveyors : C. H. Johnson (Machinery), Ltd. Exhausters, ammonia washers, meters : W. C. Holmes and Co., Ltd. Condensers : Ashmore, Benson, Pease and Co. Electrostatic detarrers : Whessoe, Ltd. Gas valves : Westwood and Wrights, Ltd.; W. C. Holmes and Co., Ltd. Water pumps : Sigmund Pumps, Ltd. Boiler feed water treatment plant : William Boby and Co., Ltd. Steam valves : Hopkinsons, Ltd. Tar and liquor pumps : Joseph Evans and Sons (Wolverhampton), Ltd. Instrumentation : Electroflo Meters Co., Ltd. Electric motors and alternators : The Lancashire Dynamo and Crypto, Ltd. Power house building : Peter Lind and Co., Ltd.

Gas Turbine Running on Residual Fuel

SOME details have been provided by Ruston and Hornsby, Ltd., of about three years' experimental work carried out at Lincoln on one of the company's "3CT" gas turbines adapted to burn residual petroleum fuels. Much of the work has been carried out in conjunction with Esso Development Company, Ltd., who have also carried out much investigational work in residual fuel burners and an atmospheric combustion chamber. An illustration of the Ruston "3CT" gas turbine is reproduced in Fig. 2 and details of the development of this company's gas turbine have been published in these columns on several occasions, together with the elbow combustion chamber, which can be noted in the illustration.

In a preliminary series of tests a number of ten-hour screening runs were carried out to explore the effect of gas temperature over the range from 620 deg. to 770 deg. Cent. and the benefits to be achieved from using various additives, which included magnesium compounds, zinc oxide and ethyl silicate. It was found from these tests that, whilst using magnesium, a considerable reduction would be obtained in the corrosion rate without increasing deposition.

Since these initial tests a 1000-hour test has been carried out on a fuel containing 3·5 per cent sulphur, together with 50 per cent vanadium, 26 to 62 per cent sodium, and 300 total ash expressed as parts per million. A magnesium additive was used and the test consisted of ten 100-hour runs. The turbine blading was water washed to remove the small amount of deposit on the blades at the end of each 100-hour run by means of equipment built into the turbine and fed with mains water. No stripping of the turbine was necessary for carrying out the washing process and no other cleaning was required during the 1000-hour test. The time taken for cleaning was about two hours. About 90 per cent of the deposit on the first row of turbine stator blades could be removed in this way and the turbine swallowing capacity was only 3 per cent less at the commencement of the tenth test than at the commencement of the first.

The first five-hour tests were carried out at a mean gas temperature of 700 deg. Cent, corresponding to rather more than 90 per cent of full load on the "TA" gas turbine. Fig. 1 shows detail views of the convex and concave faces of the first row Nimonic eighty stator blades after removal from the turbine on completion of this period of 500 hours' running. The photographs were taken by the Mond Nickel Company, who examined the blade and considered it to be in a satisfactory condition for further service and free from serious corrosion.

During the next five 100-hour tests the range of temperatures between 650 deg. and 750 deg. Cent. was investigated as well as changes in the additive concentration. Fig. 3 shows a view of the highest temperature blading following water washing at the end of the 1000-hour test.

It is now intended to carry out further long tests on the Ruston "3CT" gas turbine to determine the commercial possibilities of this system fully and to build up a background of general experience on the operation of gas turbines on residual fuel.

SUEZ CANAL REPORT.—The annual report of the Suez Canal Company states that the number of transits in 1954 rose to 13,215, or 3·8 per cent more than 1953, and that the net tonnage also increased, the increase being 10·3 over 1953 to attain a total of 102,494,000 tons. The increase is mainly attributed to oil tankers, this class of ship being responsible for 6925 transits and 65,012,000 tons. Ships of forty-six countries used the canal, those of Great Britain representing 32,909,000 tons, or 32·1 per cent. A scale programme of works has been initiated, of which the first part includes the creation of a by-pass at Port Said and another at Great Bitter Lake, and the widening and deepening of the canal where the cross-sectional area is less than 1250 square metres. It is expected that the work will take three years to complete.

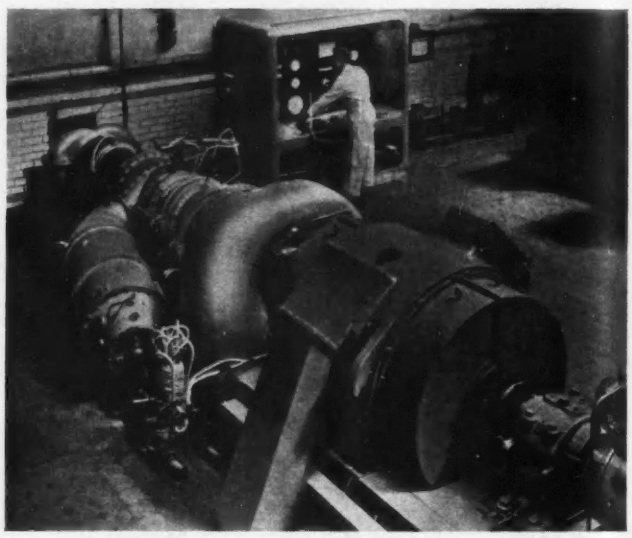


Fig. 2—The Ruston "3CT" gas turbine which has been used for the fuel tests

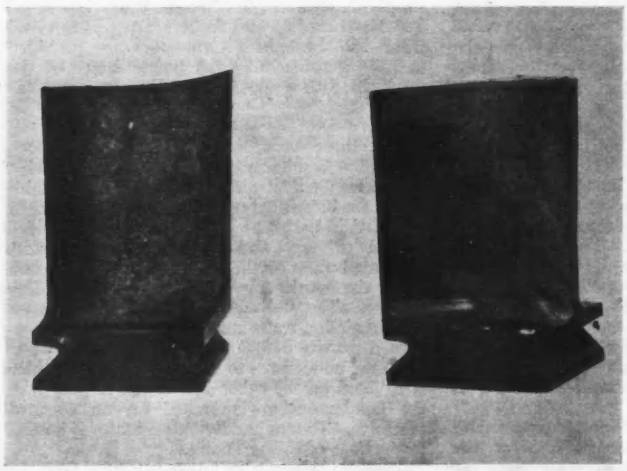


Fig. 1—Convex and concave faces of nimonic 80 stator blade after removal from the turbine on completion of 500 hours' running

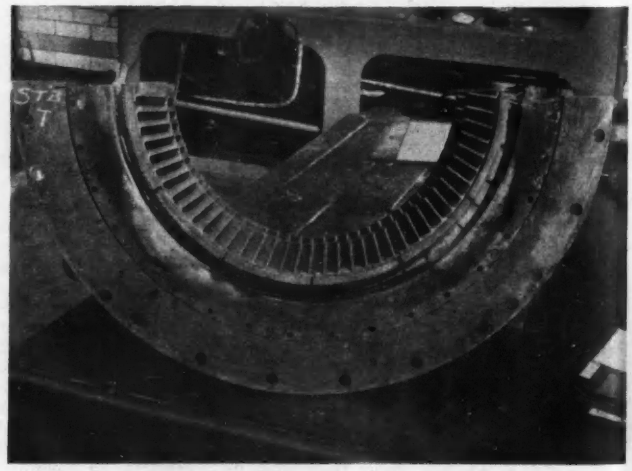


Fig. 3—Stator sector following water-washing after 1000 hours' running on Esso medium fuel and magnesium

Sawbridgeworth Pumping Station

On June 17th, the Herts and Essex Water Company inaugurated its new pumping station at Redricks Lane, Sawbridgeworth. The company is responsible for the water supply of a rural area of 146 square miles, extending from Bishops Stortford in the north, almost to Romford in the south. A considerable programme of expansion has been carried out over the past few years, and the company now supplies over 3 m.g.d. to 69,000 people. The sources of supply are wells in the chalk underlying the area, and the company operates two pumping stations, one at Roydon with a capacity of about 1·1 m.g.d., and the other at Sawbridgeworth, which is the subject of this article.

The accompanying illustrations show the care given to the layout and architectural treatment of the completed station; in the interior the tiling is coloured blue, and the columns carrying the crane rail are faced with engineering brick, which is thus used decoratively. The principal equipment is grouped, as the second illustration shows, into pumps, diesel stand-by set, and control panel. An old station on the same site, in which a triple-expansion steam engine driving well and surface ram pump sets are installed, has been superseded by the new installation, the capacity being increased by 750,000 gallons per day.

An existing shaft, 7ft in diameter and 170ft deep, was utilised for the installation of the well pumps of the new station. The shaft had been sunk in 1929, and since that time about 580 yards of headings, connected by 12in diameter mains and valves, had been constructed around the base of the shaft, in the search for water.

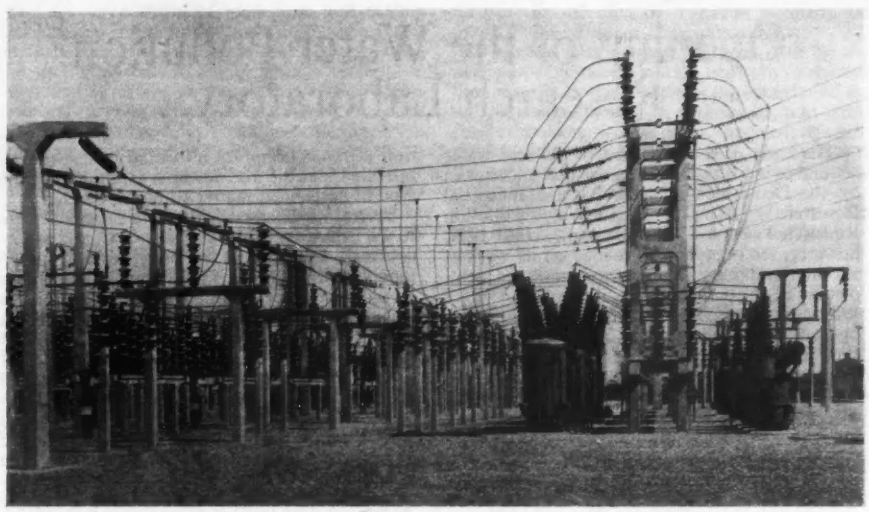
The pumping machinery consists of duplicate vertical spindle, centrifugal borehole pumps installed in the shaft and duplicate vertical spindle, centrifugal force pumps installed in the basement. The well pumps are each of 60,000 g.p.h. capacity, driven by a 110 h.p. slipring motor and may be run singly or in parallel as demand requires. The surface force pumps are also each of 60,000 g.p.h. capacity and are identical with the borehole pumps except for the difference of five instead of four stages in order to deal with increased head and less shafting between the driving motor and pump. Each is driven by a 140 h.p. slipring motor, with speed reduction up to 10 per cent by rotor resistances which are installed in the basement and controlled from the pump house. The well pumps lift water to a contact tank of 270,000 gallons capacity after simple chlorination by the injection of chlorine solution, continuously recorded, into the pump delivery main as a precautionary measure. At present simple aeration with no other treatment takes place as water enters the contact tank, but there are proposals for softening and iron removal, to be carried out later on. From the contact tank, a return suction main delivers water under positive head to the surface force pumps, which lift into supply through a venturi tube operating flow-measuring instruments.

No complicated surge problems of water in mains have been expected, or so far, appeared when the pump sets have cut out abruptly due to current failure. As a safeguard, however, the existing air vessels on the delivery main from the old steam plant are being retained in use.

The standby alternator is of 500kVA rating at 400V, 50 c/s, 3 phase and the driving diesel engine is a seven cylinder solid injection unit of 630 b.h.p. and 500 r.p.m. This rating can be increased to 693 b.h.p. for peak loads by operating the supercharged blower. Cooling of the cylinder jacket water is normally effected by a heat exchanger through which is passed, as coolant, delivery water from the borehole pumps. The set is mounted on a block of mass concrete insulated from the building foundations by 2in thick cork blocks.

In order to utilise the increased pumping capacity it was necessary to reinforce the trunk main system and a 12in diameter main was extended from Potter Street to Thornwood, a distance of 3½ miles. This main enables the company to supply the Potter Street neighbourhood area of the Harlow New Town which lies on high ground, and at the same time ensures the rapid replenishment of the company's principal storage reservoirs at Epping.

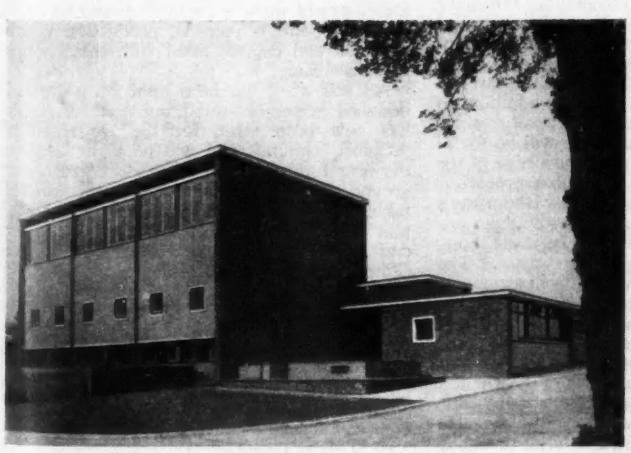
The pumping station was designed under the direction of the Herts and Essex Water Company's chief engineer, Mr. J. G. Shaw, and the architects were Messrs. Scherrer and Hicks; its cost was £122,000, about a quarter of which was for pipelines. The building contractor was James Whiffin and Sons, Ltd., the main machinery was supplied by Sulzer Brothers, Ltd., the electrical equipment by Lancashire Dynamo and Crypto, Ltd., and Erskine Heap, Ltd., and the diesel engine set by Ruston and Hornsby, Ltd.

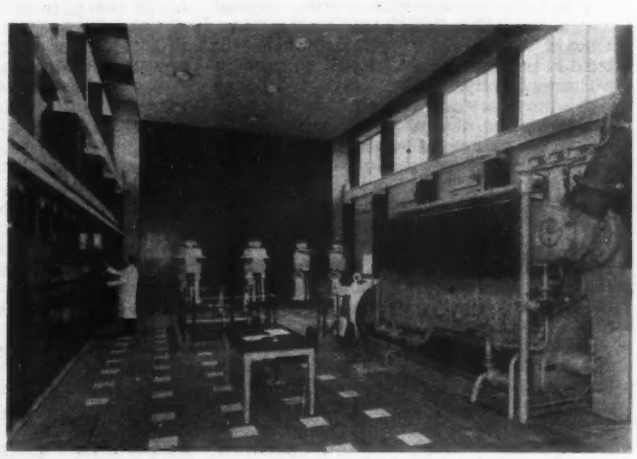


Castle Donington substation from the north-west, showing line entries, voltage transformers, oil circuit-breakers, isolators and overhead connections

Castle Donington 132kV Substation

The first section of the Castle Donington 132kV grid substation of the Central Electricity Authority was energised recently by means of a new 5½-mile long overhead line looping into one of the existing Nottingham/Coventry feeders. This section of the substation has been commissioned to enable a works supply to be given preparatory to the commissioning of the new Castle Donington power station, where the first 100MW set is expected to begin production this year. As illustrated Castle Donington substation is of the low double-busbar design and divided into three sections, the reserve bars being in the form of "horseshoes," with circuits back to back. This layout reduces the overall length of a normal double busbar station by approximately 50 per cent, but even so the length of the station is 800ft. The substation enclosure covers an area of 5½ acres. The substation will have twenty oil circuit breakers controlling three 100MW generators, two 275/132kV, 120MVA auto-transformers, two banks of two 132/3·3kV, 10MVA station transformers, three bus couplers, two bus sections, six feeders and a reactor. There are skeleton bays for a further ten circuits as required. To avoid the reserve bars of the centre section having to cross the main busbar with overhead connections, a short length of 132kV, 0·6 square inch cable, two circuits per phase, has been incorporated in the busbars. The first and third sections of the busbars are coupled by a 90MVA reactor, which has been installed to limit the fault level to the rupturing capacity of the B.T.H. 3500MVA bulk oil circuit breakers, which are pneumatically closed and spring opened.



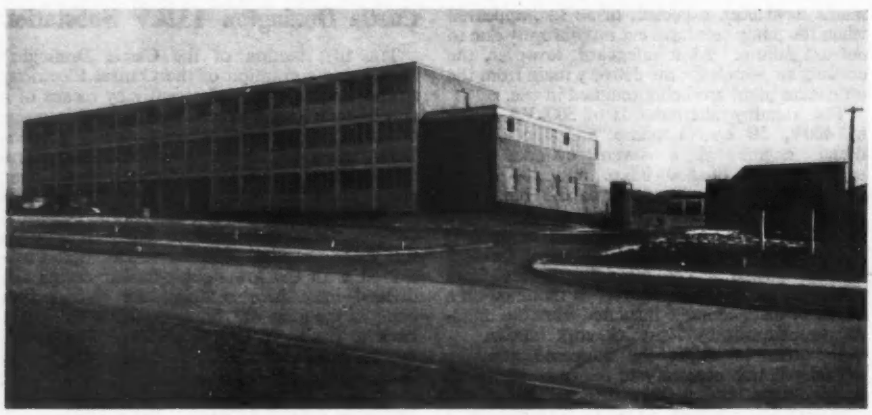


Sawbridgeworth pumping station. The interior view shows the standby diesel-alternator, the control panel and the four pump motors

Opening of the Water Pollution Research Laboratory

THE study of the treatment of polluted water and of industrial effluents was first undertaken by the Department of Scientific and Industrial Research in 1927, when the Water Pollution Research Laboratory was formed. Until 1954, however, the organisation carried on its work at various temporary laboratories, until the completion of its permanent headquarters at Elder Way, Stevenage, Herts. The new building was opened on Monday, June 20th, by the Lord President of the Council, Lord Salisbury.

The accompanying illustration shows the Laboratory, which is not far distant from the site of the town centre of the new town now being built at Stevenage. Ample laboratory accommodation is provided here, with small-scale and pilot-scale laboratories, constant-temperature rooms and workshops. There are also offices and canteens, a conference room, and a library. Large-scale experimental work can be carried on in the laboratory's grounds, and up to 70,000 gallons of sewage can be pumped daily, if required, from a sewer which crosses the site.



The Water Pollution Research Laboratory, Stevenage, Herts.

An indication of the layout and equipment of typical laboratories in the building can be given by reference to the work now being carried out. For example, although most of the analytical work required in research on treatment of sewage and waste waters is done by the section of the laboratory concerned, a room has been equipped for carrying out centrally the tests most commonly used for assessing the characteristics of a sewage. These are the biochemical oxygen demand (a measure of the polluting matter which can be oxidised biochemically), the permanganate value (a measure of chemical oxidation), and the contents of ammonia, oxidised nitrogen, and suspended solids.

One of the most important researches at present in progress is the survey of pollution in the Thames estuary. A great deal of calculating work is necessary to evaluate the results of observation, and the calculating machines installed in one part of the building are being used for this problem. A principal aim of the survey is to draw up an "oxygen balance" for the estuary —to estimate the quantity of oxygen entering the water from various sources and the amount used in oxidation. Many measurements must be made in the field, but the instruments must, in some cases, be devised by the laboratories' staff. One such instrument is a submersible turbidimeter. Information about the amount of mud in suspension required when studying silting and when determining the effect of suspended solids on the biochemical oxygen demand of the water was obtained by lowering this instrument into the water from a dinghy. Light shines from one compartment through a fixed thickness of the water on to a photo cell in another compartment. The amount of light transmitted, shown by a meter on board, gives a sufficiently close indication of the concentration of mud in suspension, provided that the instrument is calibrated for the type of suspended matter to be expected.

Several of the investigations in progress relate to the behaviour of oxygen in streams and watercourses. Experiments are being carried out on the solubility of oxygen in water, on its absorption by polluted waters and mud deposits, and on the concentrations of oxygen necessary to support fish and aquatic life under varying conditions of pollution. Basic research into the processes of sewage purification may also hinge on related problems. To understand the mode of action of percolating filters, for instance, information is required on the factors affecting absorption of oxygen from the air by the sewage. Since little is known about this, research is in progress to determine the rate at which absorption takes place and the effect of variable factors such as the design of the filter, its physical environment, the rate of application, and the chemical nature of the sewage. Preliminary experiments are being made in which clean water is applied to inert, laboratory scale, "model" filters containing a regular assemblage of glass spheres. The rate at which oxygen is absorbed by the thin films of water on the surfaces of the spheres is measured by adding to the water a large excess of sodium sulphite, which reacts rapidly with oxygen, and measuring the uptake of oxygen in terms of the amount of sulphite oxidised. The intention is to proceed gradually, as the nature of the problem is unravelled, from idealised filters to more realistic filters similar in design to those used in practice. Since it would appear that aeration in filters is probably largely governed by the rate of transfer of oxygen into thin films of water, this aspect of the subject is being studied in detail, using an apparatus in which films of measured thickness and velocity are allowed to flow over a glass plate under carefully controlled conditions. It is hoped that in addition to information which will have a practical application this will provide data which will be useful for verifying or extending our knowledge of the underlying theory of the absorption process.

Some idea of the scope of the new laboratory's work will perhaps have been given by these few examples. Mention should also be made, however, of the treatment of trade wastes. The anaerobic purification of wastes from slaughterhouses and meat packing plants is one investigation of this kind now in progress.

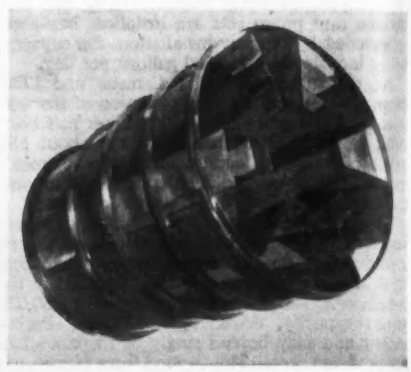
In his speech at the opening ceremony, Lord Salisbury referred to aspects of pollution—of the need to improve the condition of the Thames estuary, of the disposal of synthetic detergents, and of the treatment of radioactive wastes. He looked forward with particular interest to results of researches on radioactive wastes, which, he said, promised to be a very live question in the next fifty years.

Reduction of Airborne Jet Noise

THAT the noise from jet-engined aircraft can cause considerable public nuisance has long been recognised by the Ministry of Supply and a large amount of work has gone into developing means of reducing this noise. The noise from aircraft being run-up for maintenance purposes may be dealt with by mufflers and running-up pens of the type already being developed but the reduction of noise at take-off and in flight must be dealt with by other means.

For about four years Rolls-Royce (amongst others) have been engaged, under contract to the Ministry of Supply, on the development of means of reducing jet noise at the source by devices which are, in effect, part of the engine installation. The requirements of such devices are that they must give a useful noise reduction with no effect on engine performance. The magnitude of the problem may be appreciated when it is realised that a 10,000 lb thrust jet engine generates sound energy at a rate equivalent to 100 h.p.

After some preliminary work on silencing systems which had only limited success, the concept of "corrugated nozzles" was arrived at. These replace the usual convergent propelling nozzle of a jet engine and consist of nozzles with longitudinal corrugations or flutes. A range of nozzles with different numbers of corrugations from sixty to four was made and tested. The results it was stated by the company were most encouraging; the jet noise was reduced and, carefully designed, the nozzles did not affect the engine performance. The pitch of the noise affected by the corrugations was found to depend upon the number of corrugations, and a nozzle with six corrugations caused the largest reduction in the loudest part of the jet noise.



The sound reducing corrugated nozzles for jet engines

The latest nozzle to be tested, gives a noise reduction of 11–12 decibels which means a reduction in loudness to less than half and corresponds to the difference in noise heard on the ground between an aircraft flying overhead at 1000ft and one flying at about 3000ft. Development work is continuing, and when the optimum point is reached, production will be arranged and engines fitted with these nozzles made available.

All this work has been done on a specially designed engine test-stand, but a set of nozzles has now been made for the De Havilland "Comet" aircraft and will be flight tested in the near future. Since the noise heard on the ground from a jet-engined transport aircraft taking off is about nine decibels more than that from a comparable propeller driven aircraft, by fitting corrugated nozzles jet aircraft can be no noisier than propeller types.

ONE-MAN ESCAPE CHAMBER.—The Admiralty has developed the one-man escape chamber, and live trials of a prototype unit were conducted recently from H.M. submarine "Solent." For the purpose of the trials the submarine dived to the sea bed in Loch Ewe and six ascents were made, using the chamber, three from a depth of 80ft and three from 128ft. All the ascents were made by the Submarine Escape Training Staff of H.M.S. "Dolphin" and demonstrated the efficiency of the submarine escape immersion suit, no underwater breathing apparatus being used, as the chamber relies on the "free ascent" principle.

The Computer—Electronics' Contribution to Production*

By R. H. BOOTH†

AT an I.Prod.E. Conference it is not surprising to find the word "Production" in the title of a paper, and if the conference is in 1955, it can be expected that the word "electronics" will appear somewhere. But why "computers"? What have they to do with the automatic factory, and why should they be hailed as a contribution to production? There are naturally many answers to these questions, but it is proposed in this paper to concentrate on one theme, control.

Production engineers are vitally concerned with control—control of materials and control of processes, which in turn means control of timing, of temperature, of dimensions, of many other variables which only too often live up to this name. Control mechanisms of one sort or another are old and widely used, and electronics has long played its part in the process.

A good example of the use of electronics in introducing precise control is given by the application of the ignitron to resistance welding. Without its use, or the use of some other electronic switch, short, heavy current welds are very difficult to obtain, because the currents cannot be adequately handled by ordinary relays and contactors. Furthermore, the time is not controlled accurately, whereas with an ignitron circuit the weld can be made to last a predetermined number of cycles and to consist of a defined fraction of each.

Fig. 1—Copy cam milling machine

This is a very simple form of control, because only one quantity, time, is controlled. Equally simple, and less complicated to carry out, is the use of an ordinary thermostat in maintaining a constant temperature in an oven.

The main function of these controls is to keep some quantity, such as time or temperature, constant. An only slightly more complicated case is where the controller has to make one quantity directly depend on another.

None of this, however, can be called computing. What is a computer? What type of control qualifies to be called computing? For the purposes of this paper, a computer is defined as a box whose output or outputs depend on the values of two or more inputs. This type of controller can be non-electronic, but is almost always driven to electronic methods because combinations, i.e. multiple functions are much more easily dealt with in that way.

As an example of the successive degrees of complication of control, consider how a milling machine can be made to operate automatically. It is assumed that it is required to cut a cam.

In the purely manual use of a milling machine, the relative position of workpiece and cutting tool is controlled by hand setting; the blank may be fixed to a turntable and a slide moved so that at successive angles enough material is removed to arrive at the correct radius. This method fits a specification or drawing in which the cam is defined, in polar co-ordinates, by a table of figures and it is left to the operator to blend the successive points into a smooth line.

By successive cuts, with intervals between for inspecting what has been done, a skilled operator will be able to make a cam which will comply with the drawing. Having done so, a machine such as that shown in Fig. 1 can be used to make further samples.

This machine has two turntables, linked by a longitudinal shaft so that they turn together. One table, as before, carries the work being machined, but instead of being manually controlled, its slide position is held so that the distance between the tool and the centre of the table is the same as that between the centre of the other table and a "fixed" copying stylus. To do this requires only a simple proportional servo system, with the pressure on the copying stylus (converted into infinitesimal movement) giving rise to motor drive on the leadscrew controlling the slide position. In the diagram (Fig. 2), pressure on the stylus S from the master M is amplified in A_2 and provides the motive power for the motor M_2; this is geared to the leadscrew L_1 and if the sense (positive or negative) of the connection is right, the system will operate at any point round the periphery to keep the pressure on the stylus substantially zero and thus keep the other table away from the cutting head by an amount equal to the radius of the master at that point.

There has intentionally been no mention of how the pressure on the stylus is converted into motive power of the motor; indeed there need be no motor, in the sense of a unit providing rotary motions to a leadscrew. The stylus could operate a hydraulic system in which it released substantially greater oil pressure which directly propelled the table. Or the pressure could be converted in various ways into a voltage, which is amplified in an electronic amplifier to drive an electric motor. As long as only the simple proportional control is wanted, it does not matter which is done.

But suppose an extra requirement is added; that when a steep cut is being made, the table speed is to be reduced so as to avoid excessive linear cutting speeds. This is not so straightforward hydraulically, but can easily be carried out electronically.

The diagram had perforce to illustrate a particular type of servo system and has, in fact, shown an electronic method of achieving the extended aim.

A transducer T is used to convert the pressure on the stylus S into electrical voltage and there is a tachogenerator G_3 to provide velocity feedback for stabilising purposes in accordance with the dictates of ordinary servo theory. This same generator is used to control the speed of the table motor M_1. As shown, this motor will run so that the sum of the voltages from the potentiometer P and the longitudinal generator G_3 (as modified by the function box F) balances its own generator voltage from G_1. If F is set so as to attenuate G_3 completely, then M_1's speed will be simply proportional to the potentiometer setting, but as G_3 is allowed to become effective, it will act so that an increase in radial speed will reduce the "demanded speed" from P and so the actual speed of M_1. The latter is now controlled from more than one source and so there is a computer, however elementary, at work.

In spite of this complication, the positional control of the table position has remained a simple one. But if automatic control of this machine is carried a stage further, to the extent that it needs no master to work it but can use information direct from a drawing, then it will be found that the position of the table has to depend on more than one item of information, and there is still more computation.

Information on a drawing is rarely continuous, particularly when it is for a contour of this sort. Usually the information is in the form of a table of figures and as such it must be fed into the machine. Well-known techniques for recording information for machine purposes exist; punched cards, punched tape or magnetic tape can be used. Punched tape is often convenient.

When the hole pattern has been read by the machine, it cannot be used in isolation to control the table position. If it were, the table could do no more than proceed in a series of jerks from one dimension to the next, and could only produce some semblance of the required shape if the points on the tape referred to angles extraordinarily close together.

If, however, two points are used by the machine at a time, then as soon as it has read the first pair

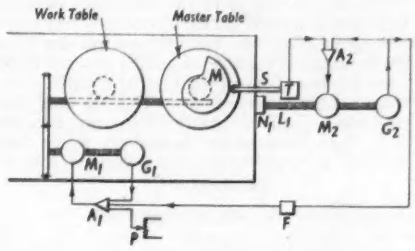


Fig. 2—Diagram of simple copying machine

it knows where it must go to next and can act appropriately. It can draw a straight line from one point to the next and proceed along it.

This is a rather anthropomorphic argument but it can be turned into terms more appropriate to engineering. Consider the block diagram in Fig. 3.

Looking first at the slide, the second turntable has been removed and replaced by a new leadscrew L_2 working in a nut N_2 and bearing on the copying stylus. It also reproduces a feed-back voltage from a potentiometer P_2. The motor M_2 drives the leadscrew until this voltage balances that from potentiometer P_2 which is derived from the tape.

The arrangements for driving the turntable are unaltered, but a synchronous link, SY, has been added between the table and the tape reader. The latter thus proceeds from line to line on the tape as the table rotates, which is equivalent to running down from line to line in the table of dimensions, and as a new line comes in it is retained or "remembered" until the next line is available and is the means whereby two points on the contour being machined are used together.

Advantage has been taken in the relay stores of other contacts to obtain voltage outputs. This is done by using each relay to switch in a voltage proportional to the significance of its digital or hole position. The two voltages can now be applied to opposite ends of the potentiometer P_2, whose slider is driven with the tape reader from the synchronous link. A duplicate of P_2 may be used to assist change over from a pair of points to the next pair.

The overall effect of this circuit is to extend the leadscrew L_2 by an amount equal to the radius of a polygonal figure composed of lines joining the successive points represented by the dimensions in the table, this radius varying uniformly between adjacent reference points.

With this system there will be no sudden jumps in the position of the leadscrew L_2 and the main servo system will continue to drive the leadscrew L_1 so that the table takes up a longitudinal position relative to the cutting tool corresponding to the polygonal figure above.

Although there are no sudden jumps in the position of L_2 its rate of movement will change suddenly as each new point comes in, and this means that the resultant shape has sharp corners. This can be remedied if we allow the machine to take notice not only of the next point, but of the one after that as well, so that the curvature of successive lines, each now passing through three points, can vary in such a way as to make each "touch" or blend with its neighbour. There will now be, in general, an abrupt change of curvature when two lines join, but this is a far less serious matter than a change of direction.

To make use of three points instead of two requires extra relay stores (Fig. 4) and a new unit called a parabolic bridge, shown only as a block.

Examination of Fig. 4 shows that there are two independent loops. One, comprising A_2,

* Paper presented June 17th, at the conference, "The Automatic Factory—What Does It Mean?" held by the Institution of Production Engineers at Margate.—Abridged.

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M_3, N_2 and P_2, keeps the leadscrew L_2 at the place dictated by the tape ; the other consists of L_2, T, A_2, M_2, L and N. It positions the table on the instructions of L_2 and thus, indirectly, of the tape. The first loop can be eliminated by putting P_2 on L and then using the output of A_2 to drive M_2. The disadvantage of this arrangement is that all dimensional accuracy is referred to a leadscrew (L_1) which bears a considerable load and which is therefore more subject to backlash errors.

Analogue Computing

During the course of the imaginary development just described, a simple manually controlled milling machine has been turned into an automatic machine, capable of milling the cam direct from a piece of tape produced by a typist direct from a table of dimensions. This has only been possible because automatic computing facilities have been introduced, controllers which take account of information from various sources,

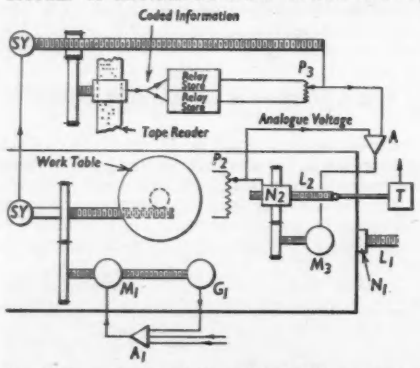


Fig. 3—Tape input and linear interpolation replacing the second turntable in Fig. 2

including internal stores or memories, and use it all for guiding the machine's future actions.

This computing has been analogue computing. It is so called because there is always a physical representation, an analogue, of the quantity being computed, in another physical form. The most usual one, and the one employed here, is the representation of length or angle as an electrical voltage. This is common because of the ease with which voltage is converted to and from other physical quantities, e.g. from angle of rotation by means of a potentiometer, and the ease with which different voltages can be combined and modified, particularly if they are alternating voltages and transformers can be used.

With a physical quantity, whether a length or a voltage, there is a limit to the accuracy with which it can be known. This is not important in computing, providing that the analogue quantity, in the present case voltage, can be known more accurately than that which it is representing. Jig borers apart, it is doubtful whether machine tools can be considered more accurate than one part in ten thousand (0·001in in 10in), and this is the accuracy, with perhaps two to one in hand, which should be aimed at in the electrical computing circuits. Until recently this was not possible, but a new technique has recently been evolved which enables voltages (strictly speaking, their ratios) to be manipulated to an accuracy of 1 part in 50,000 or better.

Analogue computing is also particularly appropriate when it is necessary to control physical quantities which can vary continuously, such as the table position in the machine tool. When, however, artificial concepts such as money are involved, analogue computing ceases to be so apposite, because with non-natural or non-physical quantities there is rarely a limit of accuracy which can be unambiguously stated, and the quantity rarely changes continuously. In these cases digital computing is appropriate. It is much more similar to conventional calculation, whether done mentally, with pen and paper, or by abacus or bead frame, methods it may be remembered which were primarily developed for financial reckoning.

Digital computing deals in numbers, in states, in "is's" and "isn't's," not in quantities. An electronic computer is not in general concerned with how many volts there are on a wire, but whether there is a voltage there or not. Ultimately, of course, there must be a limit at which one says, "above this is something, below nothing," but successful design ensures that this limit is rarely if ever approached from either direction.

Analogue computing was considered as applied to an individual machine tool, to the direct control of the physical process. Digital computing may now be used to extend this control to the working of the whole factory.

Start of the Process

The process may be assumed to start with the placing of orders on the shop floor. There is no reason why it should not start earlier, but to do so would invoke no new principles and would not help the understanding of the more restricted phase.

It is further assumed that there is a description of each article in terms of the processes that will make it ; e.g. how many hours of machining, how many of plating, of assembly, how much raw material and so on. We will assume that there are many different articles being manufactured at once in the factory, and so planning and scheduling are extremely complex problems. It will be seen immediately what a big step forward this is from the machine tool problem, where the computer only had to take account of two or three items of information.

As in the machine tool problem, the first step is to put the information into a form that the computer can assimilate. Punched tape could be used again, but it is probably more convenient to assemble a stack of punched cards, each carrying all the information concerning one article or operation, or to use direct keyboard entry.

A batch of cards, a day's worth or a week's worth, having been put into the machine, the totals of each class of work and each type of material can be arrived at. To go further than this, the computer requires knowledge of other things, the total capacity available, the raw material stock position, and so on. This means the possession of quite large storage facilities. Stores were met with in the machine tool computer, but these served only as temporary stores for retaining one or two dimensions until that part of the contour had been machined. The stores required in planning computers may be described as permanent stores ; although the information in them may and will change, the changes are in random sequence and occur at random intervals. If an article requires two dozen 4BA screws, then its passage through the computer will alter the stock position by that amount, but the next article that comes along may use 4BA screws or it may not. If it does, the item that follows the screws will in general be totally different from the first two articles.

Also, the size of the stores is very much larger than previously experienced. Each milling machine relay store was capable of holding one number of four or five decimal digits ; if a stock list contains 10,000 items, it may need to hold that number of four digit numbers for identification alone. In addition, another four digit number will probably be required for the stock position, and a third for minimum stock ; other information perhaps required to be catalogued under each item includes the value of a single unit and the time taken on average for new deliveries. In computer language this may add up to a store of getting on for a million bits, compared with the fifteen or twenty of the relay stores.

Such stores are conveniently built in the form of magnetic drums. A drum 8in in diameter and 8in long can store a million bits and be referred to by the machine in a fraction of a second.

Another store is required for shop capacity under whatever headings, such as turning, milling or assembly, as are appropriate. This may be of varying degrees of thoroughness, ranging from a mere block allocation of hours to a detailed allocation of each hour of the day to a particular job.

In this latter case it may be supposed that the system is to carry a forward load of a month—say 200 hours—and that there are 250 units, either machines or men, to be considered. Then storage is required for 50,000 unit-hours, and it will here be assumed that there is no point in breaking down the time further than one hour. Each article is assumed to take 500 hours on the average and to be broken down into fifty operations. Thus, to each of 50,000 forward man-hours, a four digit job number is to be allocated. This again means a store of about a million bits, but considerable economies can be made because each operation will normally take more than one hour.

A further input will be required ; the store representing available capacity must always start at the right point. The meaning of this will be seen if the system is considered as it might start up after a long shutdown ; the first card calling for, say, turning capacity is loaded and will take the first, say, ten hours of lathe time ; others will go on in parallel until one comes along indicating the need for capacity in excess of that immediately available. It must then take its place in a queue, and be timed to begin as soon as the first machine is estimated to be free. But this estimate may be wrong ; as soon as a better estimate, or the news that a job has finished, is available, it must be entered into the machine so that any computation of the completion time of future jobs is as up to date as possible. It is important to have this information in the machine at the earliest possible moment, and so a direct keyboard entry should be used.

A number of outputs will be wanted as well. Immediately on entry of the first card, there should be a printed output of any raw material or component shortages. Another output channel should print out the completion time of each article, as computed on the basis of the information inside the machine, and other information which should appear automatically includes re-order requests, when minimum stock is passed on any raw material, and item, unit or article costs both estimated and actual.

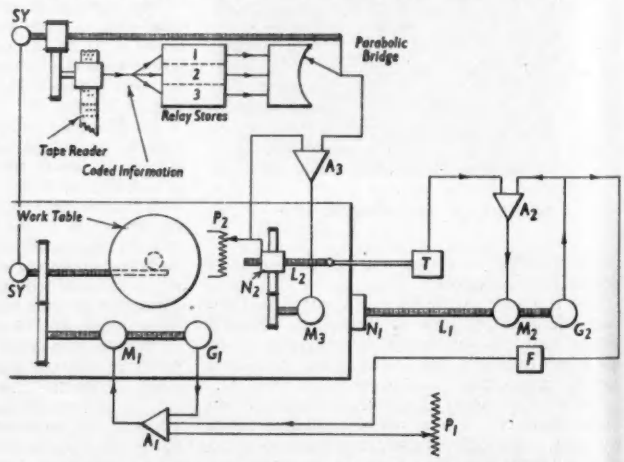


Fig. 4—Complete automatic machine tool with interpolation

We may then envisage the operation of such a computer as follows :

(1) Shop loader keys in jobs to be done as they are received from estimators.

(2) Computer refers to material stock drum and prints out shortages, with average delivery time.

(3) If no material shortages (or perhaps no delivery dates longer than a certain time, say two weeks), takes up next free line on each class of work.

(4) Based on this allocation (which must, of course, take into consideration such principles as the manufacture of piece parts before assembly)

the computer prints out a schedule showing the anticipated delivery of each item fed in at (1).

(5) Completion of any item is fed into the computer by a suitable operator—perhaps the shop clerk or a stores clerk, or inspection personnel. Also keyed is the actual time taken (for costing purposes) if the computer does not already have enough information to deduce it.

(6) As each item is complete, the computer issues information to the shop for the next item. This will only be done if there are no material shortages, and it should be possible to issue store vouchers during the course of the preceding job so that material is already earmarked.

(7) The information entered under (6) will immediately affect the internal organisation of the machine but will not print out new schedules until a routine regular time (say, once a day) or on request.

(8) As raw material stocks are depleted, reorder requests will be printed out, either at a minimum stock level or at an anticipatory time dependent on delivery time and previous rate of usage.

(9) Also printed out will be costs, at whatever stage and in whatever detail they may be required.

It will, it is hoped, be appreciated that the above description of a hypothetical machine is intended to be suggestive only. Many stages of design, electronic and clerical, are required to turn such a broad conception into physical reality.

The above examples have been concerned, rather narrowly perhaps, with various sides of the mechanical engineering industry. The principles have in fact an unlimited field of application, to any case where automatic control of one sort or another is required. There is, for example, the automatic weighing problem.

The computing in this case is mainly involved in converting a succession of individual weights into a cumulative one. The equipment basically consists of a weighing machine having an electrical pick-off system, used to preselect the amounts of various substances needed by a particular process. All the substances are heaped on the scale-pan in turn before the discharge and the scales are therefore concerned with cumulative weights only. The preselection can be carried out in several ways, including dial setting and the use of punched tape.

Power-Arm Drilling Rig

A NEW power-arm drilling rig, produced by Hands-England Oilfields Equipment, Ltd., has completed preliminary tests and although primarily designed for oilfield prospecting work, is suitable, with minor modifications, for drilling water wells, quarry blast holes and other mineral prospecting work. The "Drillmaster" power-arm drill, which we illustrate set up for drilling, represents an advanced approach to the truck-mounted drill problem; the power is centred upon the arm which is pivoted at its front end, while the rotary head is mounted in trunnions at the rear of the arm. In conjunction with hydraulic jacks the arm hoists the drill pipe and applies additional loads to the drill string during drilling. The "Drillmaster" 300 P.A. power-arm rotary drill has a rating of 300ft of 2¾in drill pipe, a rotary speed ranging from 80 to 240 r.p.m., and a rotary power of 15½ h.p. at 240 r.p.m., corresponding to 4000in-lb torque. Maximum hoisting capacity is 3900 lb at 120ft per minute, while the maximum power feed is 3500 lb at 8ft per minute.

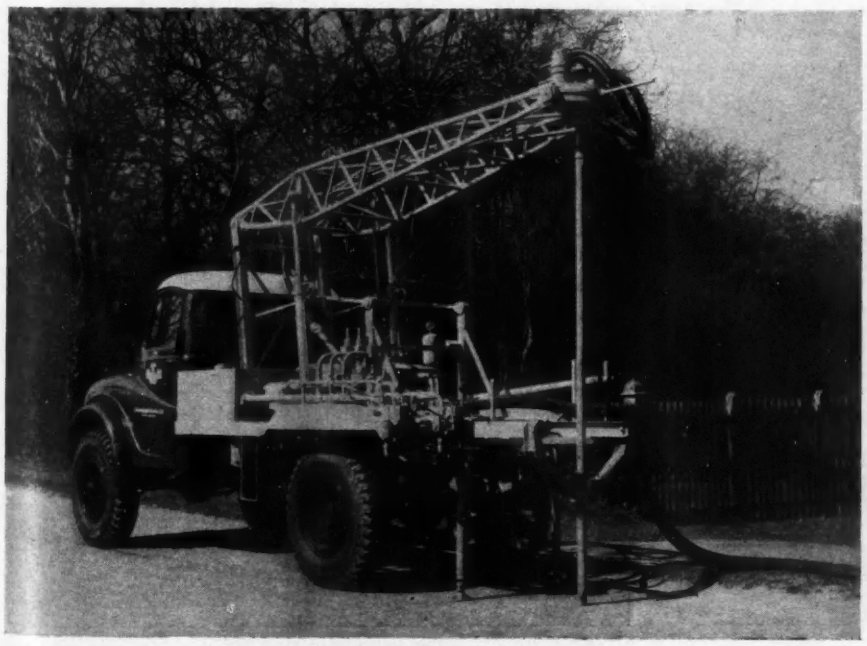
Many advantages are claimed for the design and, during drilling, quicker additions to the drill pipe are possible, since there are fewer joints to make and break, there is no unnecessary hoisting and lowering of drill pipe to make connections, and no Kelly and drive bushings are required, so that all units of the drill string are identical. The rotary head and swivel are combined in one mudtight unit mounted above the drill string and therefore not subject to flooding by drilling fluids such as occurs with more conventional arrangements. Further, since no large opening is required, smaller heavy-duty bearings are incorporated in the rotary head. The quicker additions to the drill, already mentioned, mean the minimum stoppage period for the drilling fluid and the elimination of the difficulty of returning the bit back to the bottom of the hole. A simpler and lighter drill rig is possible and finally the adoption of hydraulic transmission eliminates the drive troubles associated with the conventional rotary table.

Motors mounted in a gearbox at the upper end of the drill string rotate the drill pipe and bit, and this rotary head, as it is named, is moved up and down with the drill string by an arm pivoted at its front end. Jacks mounted a short distance to the rear of the arm front pivot raise and lower the arm, at the rear of which is sited the rotary head. A vertical straight line motion is given to the rotary head by a system of links attached towards the front end of the arm and to the front frame and these links move the arm front pivot point forward and rearward to maintain the rotary head above a fixed point. The link system adopted is a modified form of the Scott-Russell straight line motion. A guide mounted a short distance above the ground holds the drill pipe and bit vertically and prevents the bit from wandering when beginning drilling.

The rotary head consists of a thick-walled spindle, through which the drilling fluid is passed into the drill string, at the top end of which is a wash pipe and packing arrangement surmounted by the gooseneck. Two diametrically mounted hydraulic motors drive the spindle through a common gear mounted on the spindle itself. Support for the spindle is provided by roller bearings, to take the radial loads, and a duplex ball bearing to take the thrust loads. Both gearing and bearings run in an oil bath, while the upper roller bearing is flood lubricated at intervals. Trunnions cast on the rotary head body form the arm mounting. The arm, which is cross-braced to give rigidity, is constructed of electrically welded alloy steel tubes.

Hydraulic power serves the whole rig, twin hydraulic cushioned jacks serve the hoisting and power feed, while the hydraulic motor driving the 3½in by 5in duplex mud pump is identical with the rotary head motors. A simple hydraulic circuit permits three forward and reverse speeds at the rotary head and two up and down speeds at the hydraulic jacks, the low speed closing of the jacks is for power feed and allows additional weight to be added to the drill string as required. The control valves are mounted in a position easily accessible to the driller and the hydraulic lines are protected by relief valves which can take the full oil supply so that the rotary head can be stalled or the lifting capacity exceeded without damage. The oil is filtered about every three minutes.

In the centre of the guide is a pair of bronze guide bushes, through which the rotating drill slides. Each half of the guide bushing has handles so that it can be removed to uncover a tapered hole in the centre of the guide, into which the three-piece drill pipe slip, assembled as one unit, is dropped. The removal of a further bushing reveals a larger hole having tapered walls for handling casing slips, the maximum size of casing being of 5in nominal bore. Larger size casing can be run into the hole by using a spider and slips with the guide assembly removed. With the employment of certain additional components it is possible to use the power-arm for drilling with small-diameter casing where loose caving formations make this method an advantage. The only mechanical drives are from the power take-off to a small chain case, from which two short propeller shafts drive the hydraulic pumps.



Truck mounted power-arm drilling rig

Hydro-Electric Scheme in Northern Ireland

THE Northern Ireland Ministry of Commerce has introduced a hydro-electric scheme to develop the natural resources of power in the waters of the River Mourne and its tributaries, which are now used only on a small scale for the generation of electricity at a private station. The scheme provides for the construction of a dam with a hydro-electric generating station having a capacity of 18MW near Mulvin, on the River Mourne, and a second dam with a hydro-electric generating station having a capacity of 9·5MW near Sion Mills on the same river. The scheme also provides for the electrical interconnection of the stations and for their connection with existing power sources. The combined stations should be able to produce about 78,000,000 units annually, which is equal to more than 9 per cent of the total quantity sold in Northern Ireland in 1954. The estimated cost of the scheme is £3,750,000, and it is computed that the annual cost of producing the 78,000,000 units would be some £100,000 less than their cost of production in a modern coal-fired station, at the present cost of coal. The saving of coal would be some 47,000 tons a year. One purpose of the scheme is to extend the main high-tension transmission system from its present terminus at Omagh to the proposed stations: at present the principal generating stations are all situated on the East Coast (at Belfast and Ballylumford).

Colorado - Big Thompson Project

BY OUR AMERICAN EDITOR

No. IV—(*Concluded from page 860, June 17th*)

For the past fifteen years the Colorado - Big Thompson scheme of the U.S. Bureau of Reclamation has been the major civil engineering work under construction in Northern Colorado. The scheme is now almost completed and, in fact, functioned last summer to save irrigated lands from crop failure due to drought. It gathers waters on the western slope of the Rocky Mountains and diverts them through a 13-mile long tunnel underneath the Continental Divide to the eastern slope, there supplementing the irrigation water supply. The potential of the water is used in several power stations to generate approximately 600 million kWh annually.

Estes Power Station

THE Estes power station, which is shown in the accompanying illustration, is situated at the upper end of Lake Estes, near the eastern outskirts of the village of Estes Park. This three-unit installation serves as one of the "peaking" plants for the Colorado - Big Thompson power system. The Marys Lake reservoir provides forebay storage for the operation of the Estes units, and from the Marys Lake reservoir the water flows through the Prospect Mountain conduit and pressure tunnel to the Estes gatehouse, where it enters the Estes penstocks to be transported through the Estes power station to Lake Estes. The estimated average annual output of the Estes plant is 113,100,000kWh.

The Marys Lake reservoir, which occupies a natural basin enlarged by the construction of two small earth and rock fill dikes, has a total capacity of 1107 acre-feet. The estimated daily peaking requirements at the Estes power plant demand 345 acre-feet of water, and, in addition, the reservoir has 150 acre-feet of storage reserved for the water content of 16 miles of supply conduits and tunnels from Grand Lake, should the downstream works be stopped under emergency conditions. The intake structure of the Prospect Mountain conduit at Marys Lake has an 80ft venturi section with a trashrack mounted at the entrance. At the end of the transition section provisions have been made for a 12ft 6in by 12ft 6in hydraulically operated fixed-wheel gate equipped with a hand pump for emergency operation.

The Prospect Mountain conduit and pressure tunnel consists of reinforced concrete pipe and tunnel sections, each with a 12ft 6in diameter and a 1300 cusecs capacity. The conduit is designed to operate under a static head of 41ft and the tunnel under a static head of 67ft 6in. A restricted orifice surge tank, 50ft in diameter and 100ft high, is situated about 200ft from the outlet portal of the tunnel. This surge tank provides surge protection for the 1·67 miles of upstream aqueduct and provides storage which enables the generating units at the Estes power station to pick up load quickly. The Estes penstock gatehouse is a reinforced concrete structure housing three 6ft by 7ft 6in hydraulically operated high-pressure slide gates and their control equipment. The hydraulic pumps are operated by direct current supplied from batteries housed in the building. Emergency closure of these gates is activated by push buttons situated in the control room at the Estes power plant.

The three penstocks have a design capacity of 1300 cusecs, are of welded steel construction, 78in in diameter and are each about 4085ft long. They are equipped with 84in hydraulically operated butterfly valves ahead of the turbines. These valves are closed when the units are not operating to prevent leakage and erosion of the turbine wicket gates. The power station structure is of reinforced concrete. A machine shop has been provided to make minor repairs to the generating units, and the control room has the equipment required for the remote control of the Marys Lake power station and the Olympus dam gates in addition to the control equipment for the Estes installation. The generator head losses are used to heat the building partially.

Each generating unit of this station consists of a generator with a rated capacity of 16,667kVA and 0·9 power factor when driven at 400 r.p.m. by a turbine rated at 21,000 h.p. under a net effective head of 482ft. The best efficiency occurs when operating at a net effective head of 515ft and delivering 21,200 h.p. The units are designed for a runaway speed of 700 r.p.m. at a 548ft head. Due to the long penstocks, a pressure regulator is provided for each turbine. The generators may be motored on the system to provide voltage regulation or for spinning standby capacity. When the units are motoring the butterfly valve on the penstocks is left open to permit leakage of water past the turbine wicket gates to cool and lubricate the runner seals. The main leads from the generators are taken to the switchyard in an underground cable tunnel. The switchyard, which is adjacent to the power station, is a conventional outdoor yard with steel structures. Power from each generating unit is stepped up to 115kV through a bank of three 6000kVA self-cooled transformers. The Estes power station switchyard serves as a tie-point for the western slope transmission grid, the Marys Lake power station, and the Foothills power system. Lake Estes was formed by the construction of the Olympus dam and serves as the afterbay of the Estes power plant.

Pole Hill Power Station

The accompanying illustration shows the Pole Hill power station under construction in the Little Hell Canyon about 10 miles east of Estes Park and 4 miles south of the Big Thompson River in the catchment area of the North Fork of the Little Thompson River. This single-unit installation is a base-load plant similar to the one at Marys Lake. Water for power generation is supplied from Lake Estes through the Olympus siphon and tunnel and the Pole Hill tunnel and canal to the Pole Hill gatehouse, where the water enters the Pole Hill penstock to be passed through the Pole Hill power plant. The estimated annual flow delivered through the Pole Hill power plant is 340,000 acre-feet, which included 30,000 acre-feet obtained from the Big Thompson River at Lake Estes. The estimated annual power output of the plant is about 213,800,000kWh.

Lake Estes serves as a re-regulating reservoir for the Estes plant and as the forebay for the Pole Hill plant and has a total storage capacity of 2659 acre-feet, including 420 acre-feet of operating capacity. The headworks for the inlet to the 0·8 mile long Olympus siphon include two 6ft 3in by 8ft motor-driven, screw-lift fixed-wheel gates. The Olympus siphon discharges into the Olympus tunnel, which is connected to the Pole Hill tunnel by a short closed conduit. The Olympus and Pole Hill tunnels are 1·8 miles and 5·4 miles long respectively, and both are 9ft 9in horseshoe sections with 550 cusecs capacity. The water flows from the Pole Hill tunnel through a lined canal for a length of 2600ft to the Pole Hill gate structure.

The Pole Hill gate structure has a reinforced concrete sub-structure and a prefabricated, insulated metal superstructure. This structure houses a hydraulically-operated, 8ft. by 10ft 6in fixed-wheel penstock gate and an automatic siphon spillway. The gate can be opened or closed at the gatehouse and can be closed by remote control from the power station. The gate closes automatically upon load rejection, penstock failure, or low water in the power plant forebay. The siphon spillway discharging

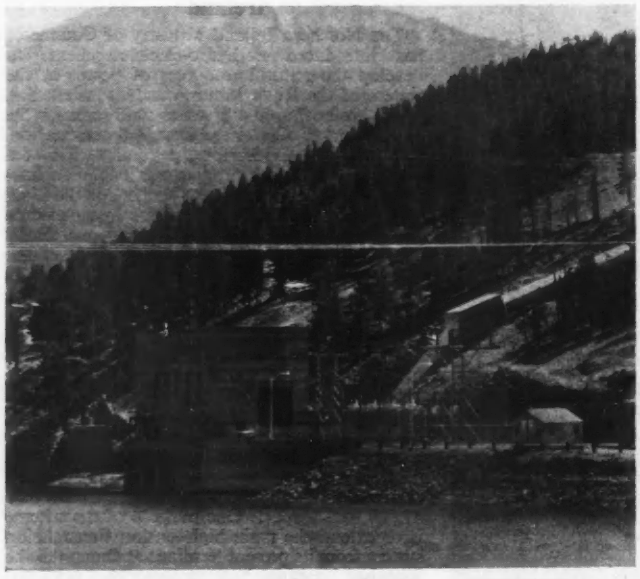


Fig. 13—Estes power station and switchyard

Fig. 14—Pole Hill power station and switchyard under construction

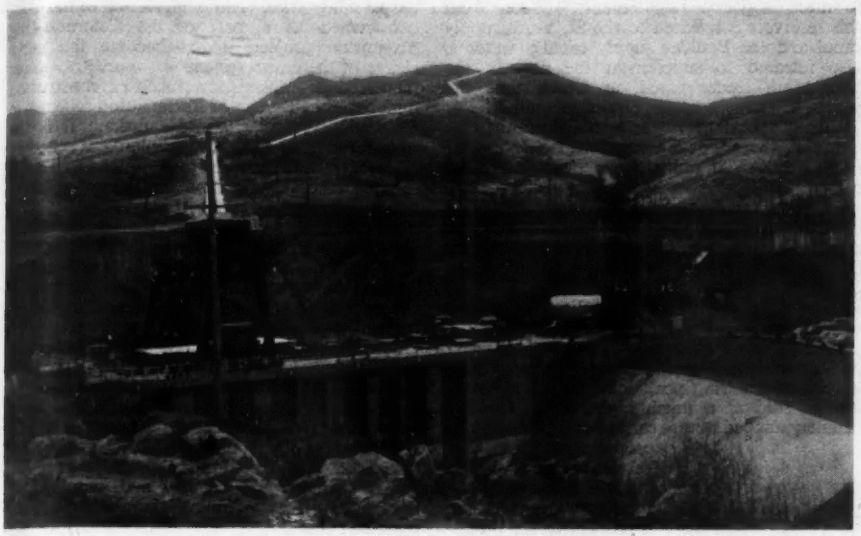


Fig. 15—Flatiron power and pumping station under construction

into a natural drainage channel provides the penstock by-pass. A check structure in the natural drainage channel diverts the water into the power plant afterbay, which is formed by a small earth dam across the tail-race channel. The Pole Hill penstock is an 8ft diameter, 1850ft long, welded plate steel conduit with a capacity of 550 cusecs.

The Pole Hill power station is an indoor installation with a reinforced concrete substructure, and its superstructure consists of insulated metal wall panels attached to a structural steel frame. The station is unattended, with local control or remote control supplied from the Flatiron power station. The generating unit of the station is equipped with a generator rated at 35,000kVA, 0·95 power factor, when driven at 450 r.p.m. by a turbine with a rated capacity of 47,500 h.p. at 815ft of net effective head. The head varies from 810ft to 840ft, and best turbine efficiency is obtained when operating at an 825ft head and 40,000 h.p. The unit is designed for a runaway speed of 832 r.p.m. The turbine is equipped with a pressure regulator with float control for operation as a synchronous by-pass similar to the equipment at Marys Lake. Synchronising the generator with the grid system is possible only at the Flatiron power station, but the generator is normally automatically loaded continuously to the maximum possible with the water available by means of a float-operated gate limit control. The main power leads from the generator feed directly into a 35,000kVA, self-cooled transformer situated on the power station deck, and the 115kV Pole Hill circuit is connected to the Flatiron switchyard situated adjacent to the Flatiron power and pumping plant.

Flatiron Power and Pumping Station

The Flatiron power and pumping station, which is shown under construction in the accompanying illustration, is situated in the Chimney Hollow at the base of Bald Mountain, approximately 10 miles west of the town of Loveland, Colorado, and 4 miles south of the Big Thompson River. This station is a peak-load plant within the power grid and contains two conventional generating units supplemented by a reversible pump-turbine unit. The rated capacity of the plant is 69,700kW. Water from the Pole Hill afterbay flows through the Rattlesnake tunnel to the Rattlesnake reservoir, which serves as the forebay for the Flatiron power plant. Water from the Rattlesnake reservoir is transported through the Bald Mountain pressure tunnel to a valve structure controlling the Flatiron penstocks. The annual flow through the installation is the same as that through the Pole Hill power plant—340,000 acre-feet. The estimated annual output from the two conventional turbo-generators is 279,500,000kWh. The pump-turbine unit adds about 1,000,000kWh during the time it generates each year.

The inlet to the Bald Mountain tunnel at the Rattlesnake reservoir consists of a trashrack structure, with provision for the control of water flow. The Rattlesnake reservoir has an active storage capacity of 1400 acre-feet, with the daily fluctuation for power peaking requiring about 400 acre-feet. The Bald Mountain pressure tunnel, which operates at a 66ft static head, is a reinforced-concrete-lined structure, 6750ft long and 10ft 6in in diameter. Near the outlet portal of the tunnel is a restricted orifice surge tank 81ft high and 50ft in diameter, having the same function as the Prospect Mountain surge tank at the Estes power station.

The reinforced concrete penstock valve structure contains two 84in butterfly valves to shut off the flow into the two penstocks. The valves have local opening control facilities and can be closed by local facilities at the valve house or by remote control from the Flatiron power station. The closing time for the valves is thirty seconds and the opening time is thirty seconds, plus the time required for filling the penstocks, which is about two hours. The two penstocks are each approximately 6000ft long, and vary in diameter from 84in at the upper end to 72in near the turbines. The penstocks terminate at butterfly valves in the power station. The reinforced concrete power and pumping station structure is shown in cross section in the accompanying drawing. It constitutes a representative example of what has recently become known in the United States as a semi-indoor installation. The station houses two conventional generating units operating with water from the Flatiron penstocks and one pump-turbine operating with water from the Carter Lake reservoir or the Flatiron afterbay. In addition to housing the

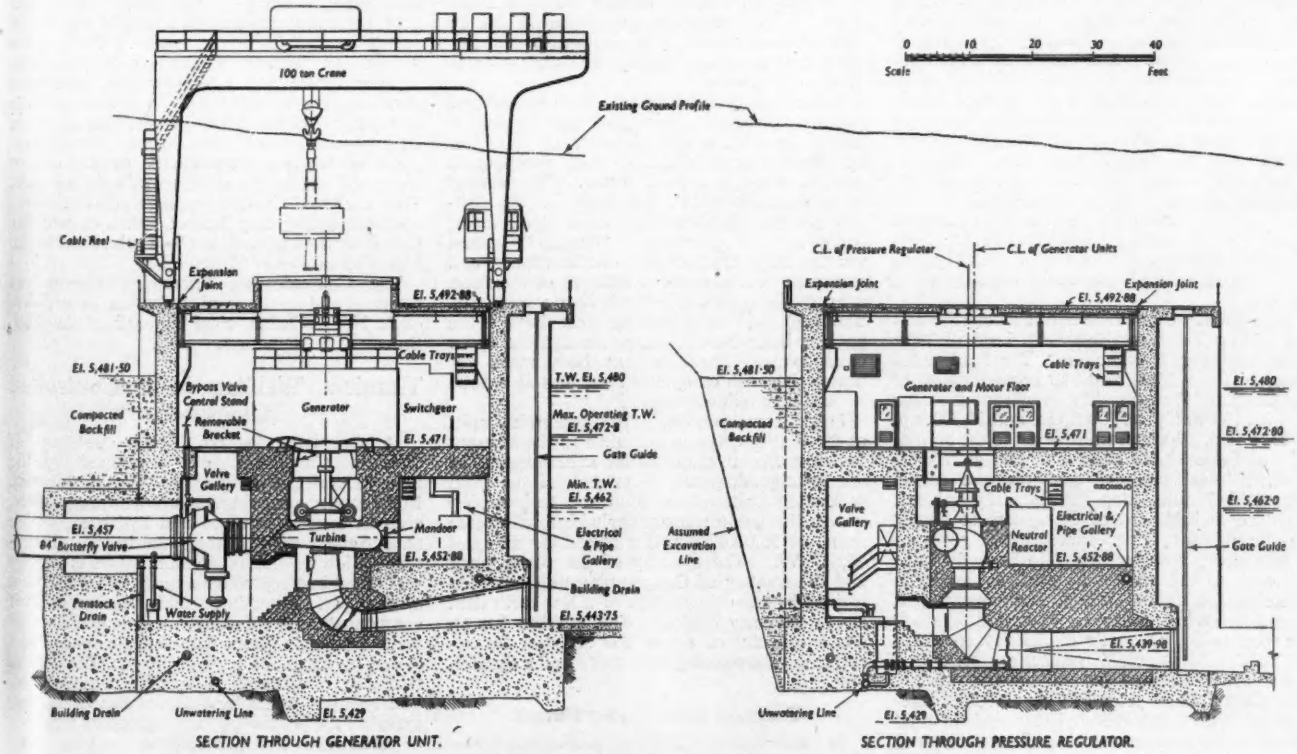


Fig. 16—Cross sections through the Flatiron power and pumping station

control equipment necessary for its own operation, the station also contains the control equipment for the Flatiron switchyard and the remote control equipment for the operation of the Pole Hill power plant.

Each of the conventional generating units consists of a generator rated at 35,000kVA and 0·9 power factor, when driven at 514 r.p.m. by a turbine with a rated capacity of 48,000 h.p. at a net effective head of 1055ft. The head acting on the turbines may vary from 1020ft to 1115ft, with the best efficiency being obtained at 39,000 h.p. and a 1055ft head. The units are designed for a runaway speed of 950 r.p.m. and each one is equipped with a pressure regulator on account of the long penstocks incorporated in the installation.

The pump-turbine is the first of its kind to be designed by the Bureau of Reclamation and is a fixed-vane unit capable of pumping or generating at two speeds. It will operate as a motor-driven pump when delivering water from the Flatiron afterbay into the Carter Lake reservoir, and as a water-wheel-driven generator when discharging water from Carter Lake into the Flatiron afterbay for delivery to the Horsetooth feeder canal. Due to the existing topography in the vicinity of the Flatiron power station and the Carter Lake storage basin, a pump-turbine was found to be the most economical installation to facilitate the transport of water to and from Carter Lake. The two-speed unit selected operates with an overall efficiency greater than a single-speed design and thus has more than justified the increased cost. A 42in submerged tube valve has been installed to by-pass the unit when the irrigation requirements exceed the water capacity as a turbine.

Fig. 17—Grid control board at the Flatiron despatching centre

When acting as a motor-driven pump the unit will deliver 370 cusecs against a head of 240ft when operating at 300 r.p.m. The head varies from 140ft to 290ft and the second speed of operation is 257 r.p.m. The synchronous motor is rated 13,000 h.p. at 300 r.p.m. and 10,700 h.p. at 257 r.p.m. Water is transported to the bottom of the Carter Lake reservoir through an 8ft diameter steel penstock and pressure tunnel system, 1·1 miles long. A butterfly valve is provided at each end of the system to permit unwatering for maintenance. No governor is provided ; however, the 76in butterfly valve adjacent to the pump is used to assist in reducing the motor starting requirements and in synchronising the unit. Provision is made for connecting the unit electrically to either or both of the main generating sets, and the motor is designed for full voltage starting. The Carter Lake reservoir has 109,100 acre-feet of active storage capacity and is used as one of the storage reservoirs for the imported water which will be released at the proper time to meet irrigation requirements. Water from this reservoir is released to the St. Vrain supply canal and the Boulder supply canal ; water is also released to supplement the flow in the Horsetooth feeder canal, at which time the pump-turbine is used for power generation.

When operating as a turbo-generator, the unit has the following rated capacities :—257 r.p.m., 8500kVA, unity power factor, and 300 r.p.m., 10,000kVA unity power factor. The amortisseur windings provided for motor starting will start the unit in either direction and the automatic field application equipment avoids the necessity of synchronising the unit as a generator.

It is well known that in applications of the pumped storage principle, pumping is done during periods of low load demand, or during off-peak periods when the power costs very little. Power is generated during peak load periods when it can be sold at a much higher rate. In this manner, pumped storage can be economical and, in proper application, can be made self-liquidating and profitable. The Flatiron pump-turbine is being used for pumped storage, although it was primarily intended for use as an irrigation pump. As the pump-turbine is not intended for regulating load it does not have movable wicket gates or a governor. When starting as a turbine, it is synchronised by means of a butterfly valve. In starting, the valve is first opened by a small amount. This admits sufficient water to bring the unit up to about 95 per cent of normal speed. Then, by opening a by-pass valve, the speed comes up to normal and the unit can be put on the line. Following this, the butterfly valve is opened fully and the generator output will correspond to the head existing at that time. Another method of synchronising is obtained by starting up with the butterfly valve to about 200 r.p.m. and motoring the unit on the line up to synchronous speed, then switching to generating and opening the butterfly valve wide open to develop full power.

Because of its dual function, the pump-turbine was developed as a two-speed unit so that it can be operated at the proper speed to obtain maximum overall efficiency when pumping as well as when generating power. The runner is submerged below the level in the tail-race so that the pump is primed at all times, ready to start pumping. "Ampco" bronze wearing rings are provided on the runner, and stationary seal rings of a different composition are provided on the upper and lower cover plates. The main shaft has a stainless steel sleeve in the packing box where it passes through the upper cover plate. Provision has been made for unwatering with compressed air, if it is desired to start with reduced torque.

Leads from each one of the generating units at the Flatiron station are taken to the adjacent switchyard in an underground cable tunnel. In the switchyard, power from each of the main generating units is fed into the transmission system through a transformer with a self-cooled rating of 35,000kVA and a forced air rating of 46,667kVA. The afterbay of the power plant and the forebay of the pumping unit has been formed by the construction of a low earth dam across Chimney Hollow. This afterbay has an active capacity of about 400 acre-feet for re-regulating the peaking flows through the Flatiron plant.

Flatiron Despatching Centre

In the immediate vicinity of the Flatiron power and pumping plant is the building housing the despatching office. Although this office has been constructed as a part of the Colorado-Big Thompson project, it has become the nerve centre of the entire systems of reservoirs, power plants, and transmission facilities constructed under various Bureau of Reclamation schemes in Colorado, Wyoming and Nebraska. It is the responsibility of this office to plan and schedule releases from the various reservoirs as well as to schedule electric generation and the transmission of power to the load centres.

The centre is officially known as the headquarters of the Upper Platte System in Region 7 of the Bureau of Reclamation. Its creation was directly due to the growth of the interconnected Upper Platte system from one short section of transmission line in the neighbourhood of Guernsey, Wyoming, into a vast network of 2200 miles of high-voltage transmission lines by means of which 110 wholesale customers of the Bureau are served. The control room of the centre is dominated by a 10ft high control board, which is shown in our final illustration. Contained on this semi-circular board is a power system diagram which shows and identifies all the power plants, pumping plants, substations, significant switching points and interconnecting ties with other power grids. There are also instruments which record the electric operating conditions and data which are required by the despatchers in performing their direction of the orderly operation of the system to achieve utmost efficiency.

Power operating conditions all over the interconnected system are recorded instantaneously on the power despatcher's control board. This information flows into the despatching headquarters by a telemetering process and includes such data as the power generation at each of the power plants on the system, total generation throughout the system, total load, interchange with other connected systems and system frequency and time error. The despatching office can communicate with key points throughout the system by means of carrier current telephone, very-high-frequency telephone, and the Bell telephone system. The Flatiron centre directs the release of water and the despatch of power on the Colorado-Big Thompson, the Kendrick and the North Platte projects and on affected parts of the Missouri River Basin project. Apart from the day-by-day, minute-by-minute despatching function, the headquarters prepares an annual plan of operation to serve as the guide for operations during each year, starting on November 1st. Long-range operational studies are made and from these are prepared estimates of the future energy capabilities of the system. The various reclamation districts, in turn, prepare estimates of their future power requirements. Balancing these two against each other, it is then possible to forecast whether it will be necessary to make outside purchases of power to meet the requirements or whether there will be surplus energy generated within the system available for sale. The results of the long-range studies are also used for establishing budget estimates and for compiling reports, such as those submitted to the U.S. Federal Power Commission.

The Colorado-Big Thompson scheme was designed and constructed under the supervision of L. N. McClellan, chief engineer of the U.S. Bureau of Reclamation.

Titanium Welding in a Controlled Atmosphere

A technique for the fusion welding of titanium alloys has been developed by the Solar Aircraft Company, of San Diego, California. In the molten state titanium absorbs many gases, such as oxygen, nitrogen and hydrogen, which tend to make welds in the metal brittle. Therefore, fusion welding of titanium alloys is usually performed in a controlled atmosphere employing an inert gas. In welding sizable titanium aircraft components, the company found it desirable to make a gas-tight plastic tent which is opened and closed by means of a zip fastener. The tent is fastened to a standard welding manipulator. The operator wears long-sleeved rubber gloves, sealed to the plastic bag, and thus gains freedom of movement. Inside the plastic tent, the atmosphere can be controlled to obtain good welds.

Industrial and Labour Notes

Locomotive Men's Wages

Following the end of the locomotive men's strike on Tuesday of last week, Lord Justice Morris, who was appointed by the Minister of Labour to act as referee in the wages dispute, interviewed representatives of the British Transport Commission, the Associated Society of Locomotive Engineers and Firemen, and the National Union of Railwaymen. These parties had all agreed that they would accept "immediately and without question" the referee's decisions.

Those decisions were announced last Monday evening. The referee was asked to decide on basic rates for drivers and motormen and to consider submissions made to him concerning the appropriate rate for "third year" firemen. The figures considered by the referee as appropriate basic weekly wages for drivers and motormen employed on British Railways were: first year, £8 16s.; second year, £9 7s.; and third year, £9 18s. The current basic weekly rates are £8 15s., £9 5s. and £9 15s. respectively, so that the increases will range between 1s. and 3s. a week. For third-year firemen, Lord Justice Morris recommended no change in the basic weekly rate, which therefore remains at £8 4s.

In the settlement of the strike it was agreed that there should be an extension of the mileage payment system which already operates on British Railways, and it was recognised that considerable benefits would accrue therefrom to both drivers and firemen. Discussions on this matter between the British Transport Commission and the two unions began on Tuesday.

Coal Stocks

On Monday last, the Minister of Fuel and Power, Mr. Geoffrey Lloyd, was asked in Parliament how much coal had been imported to date this year, and at what cost in dollars and otherwise. In reply, the Minister said that, up to the end of May, 4,500,000 tons of coal had been landed at a cost of £27,500,000, of which nearly £5,000,000 was payable in dollars. It was not yet possible, he added, to estimate the dollar cost of imports in the full year, but a substantial part of our requirements would have to be obtained from the U.S.A.

The Minister was then asked for a statement on the current coal position, and also on the effect of the railway strike upon the production, export and import of coal. In answer to this question, Mr. Lloyd said that there was little loss of coal production through the rail strike and little reduction of imports, though exports were considerably curtailed, and about 1,000,000 tons had been stockpiled on the ground near the pits. Through disputes at the mines, however, 1,900,000 tons of coal had so far been lost this year. On June 4th, total distributed and undistributed coal stocks were 13,300,000 tons against 15,200,000 tons on the corresponding date last year. All possible steps were being taken, the Minister continued, to build up adequate coal supplies for next winter. It was too early yet, however, to make any statement on the prospects for any one class of consumer.

Overseas Trade

The Board of Trade has now given some further details about Britain's overseas trade results in May. It says that, after the high level of imports reached in the first quarter of this year, the lower figure recorded for April seemed to indicate a downward trend in arrivals. That trend continued during May, when notwithstanding a longer working month, the value of imports declined to £290,300,000.

Owing to differences in timing between the dates of receipt of cargoes and the dates of recording the trade accounts, it is not possible to say with certainty whether the May figures were affected by the strike at the docks which began on May 23rd. It is clear, however, that the effect of the dock strike could not have accounted for the whole of the drop in imports. The average rate of imports in April and May was about 10 per cent lower than the average for the first quarter of the year, though still nearly 8 per cent higher than in the comparable months of 1954. At the beginning of this year, however, imports were coming in at a high rate, and during the first five months of this year were 16 per cent higher than in the corresponding period of 1954.

Exports from the United Kingdom in May, the Board of Trade says, moved in the opposite direction to imports, the recorded value being £249,400,000. In the two months April and May, the average value of exports was £247,000,000, which was only a fraction below the high level recorded in the first quarter of this year, when the effects of last October's dock strike were still noticeable. In April and May exports were about 9 per cent more in value than in the corresponding months of 1954, the volume being much about the same as in the first quarter of the year. Re-exports in May were valued at £8,300,000, making the excess of imports over total exports nearly £33,000,000. Taking the average of April and May, the excess was £48,000,000, compared with £77,000,000 a month in the first quarter of the year. The visible trade deficit in the first five months of this year averaged £23,000,000 a month more than in the comparable period of 1954.

Delays in the London Docks

In these notes in last week's issue there was a reference to an inquiry by the transport committee of the London Chamber of Commerce into complaints of delays in the Port of London, suffered by importers and exporters. An interim report on the matter has now been made by the London Chamber of Commerce, which sets out some of the difficulties and makes some suggestions for overcoming them.

This report says that the delays occur mainly to exports sent to the London docks by road transport. About this, the Port of London Authority has stated that the difficulties must be chiefly attributed to the ban on overtime working which operated early in 1954 and culminated in a complete stoppage of work last October. After the strike there was a period of great pressure to clear up the accumulated traffic, and almost as soon as the position returned to normal a further strike (which, as we go to press, is still in progress) was called by the National Amalgamated Stevedores and Dockers. At times of severe pressure some delays are inevitable, the Port of London Authority has explained, but it asserts that, with freedom from labour troubles and with the co-operation of all the interests concerned, an orderly flow of traffic can be achieved and delays can be reduced to a minimum.

In its report the London Chamber of Commerce expresses the view that the main cause of the difficulties in the Port of London is the indiscipline and lack of responsibility of sections of dock labour. The report adds that "it is most desirable that the proposed inquiry into the operation of the National Dock Labour scheme should be held at the earliest opportunity." It is also considered that a contributory cause to the delays in the port has been the shortage of adequate labour. Another suggestion made in the report is that at times of severe pressure and in order to ensure that export cargoes may be loaded in time, some form of shift working might be introduced to secure temporary relief. The London Chamber of Commerce feels that, although the trade unions and the men may object to compulsory night work, it might be possible to obtain agreement for a limited number of gangs voluntarily to undertake such work on occasions when there is congestion.

The report goes on to make some suggestions about relieving the congestion of vehicles at the docks, improving the layout of sheds, widening roadways, and setting up lightering depots. It ends by saying that the investigating committee realised that there were so many aspects to the problem of congestion at the London docks that it would not be possible to do full justice to the subject in a short space of time. It was also felt that it would not be desirable to deal in any detail with such questions as labour and mechanical aids while the dock strike was in progress.

Monopolies Commission

Several questions bearing on the work of the Monopolies Commission were answered in the House of Commons on Thursday of last week by the President of the Board of Trade, Mr. Peter Thorneycroft. He said that since the Monopolies Commission was set up, it had produced eleven reports, on eight of which action had already been taken. At the present time the Commission had nine enquiries on hand and it was expected that reports on at least three would be received before the end of the year.

Mr. Thorneycroft went on to say that he proposed to send to the Commission a further general reference covering common prices and level tendering, both of which had been much in the public mind in recent months. In addition, it was intended to make a number of individual references, but, Mr. Thorneycroft added, he wished to emphasise again that the making of a reference in no way prejudged the question whether or not the arrangements involved operated against the public interest. It was indeed one of the Commission's main functions to inquire into that point. The references it was proposed to make very shortly would be on the supply of steel frames for buildings; electrical street lighting; tea; chemical fertilisers, and electric batteries.

Human Relations in Industry

Last Friday, the Minister of Labour, Sir Walter Monckton, Q.C., addressed the International Labour Conference assembled at Geneva. His talk dealt, for the most part, with this country's experiences in industrial relationships. Sir Walter said that voluntary methods of agreement were the basic element of this country's policy, a policy which was designed to keep State direction out of industrial relations and daily work as much as possible. The British Government's view was that the "carrot and the stick could no longer be regarded as the only driving forces on which industry should rely."

Sir Walter went on to enumerate what he called five basic elements for the creation of a policy of confidence between management and workpeople. They were, he said, the payment of fair wages and the observance of good conditions; proper and adequate supervision and control to ensure an even flow of work; provision of information and the perfection of the art of communication; joint consultation, and, finally, the recognition of the human factor as being of outstanding importance.

"Better Ways"

This week, the British Productivity Council has published a booklet (price 2s. 6d.) entitled *Better Ways*. It is described as a "primer of productivity," and in it there are set out a series of case studies from various industries which demonstrate the effectiveness of improved methods. Throughout the booklet it is emphasised that such methods will produce but little result if good industrial relations have not first been established. Some of the chapters are therefore devoted to the human problem.

An introduction to the booklet explains that the object of the various techniques described is not merely to raise output. The meaning of higher productivity is to raise output, while at the same time saving man-hours, material, space, machine time or fuel and power—any or all of them at once. A sound understanding of the techniques, it is acknowledged, will not necessarily make good management, but, the booklet claims, it "will go a long way towards it."

Personal and Business

Appointments

MR. E. R. SISSON has been appointed technical services manager of Smiths Aircraft Instruments, Ltd.

BRITISH INSULATED CALLENDER'S CABLES, Ltd., announces the appointment of Mr. H. H. Daker as patents officer, in succession to the late Mr. R. L. Cleaver.

CROMPTON PARKINSON, Ltd., announces the appointment of Mr. D. H. Leeson as home sales manager of its associated company, Cooke and Ferguson, Ltd.

THE ATLAS DIESEL COMPANY, Ltd., Wembley, announces the appointment of Mr. A. E. Morgan, A.M.I.Mech.E., to the board. He has been the company's works manager since 1946.

BRITISH TYRE AND RUBBER COMPANY, Ltd., Herga House, Vincent Square, London, S.W.1, states that Mr. Thomas Hartley, Mr. S. G. Deaves, and Dr. W. D. Scott have been elected directors.

MR. W. K. TATE has been appointed managing director of Thomas Glover and Co., Ltd. He is also joining the board of the parent company, Glover and Main, Ltd., 48, Grosvenor Gardens, London, S.W.1.

THE MINISTER OF TRANSPORT AND CIVIL AVIATION has appointed Mr. J. Emlyn Jones, A.M.I.C.E., to be divisional road engineer, Scotland division, in succession to Mr. J. A. Burnett, M.I.C.E., who is to retire on October 31st.

MR. C. G. F. PRITCHETT, M.I.E.E., has been appointed chief engineer of Chloride Batteries, Ltd., Clifton Junction, Manchester, in succession to the late Mr. C. P. Lockton. He has been a director of the company since May, 1952.

DAVY AND UNITED ENGINEERING COMPANY, Ltd., Sheffield, states that Mr. W. W. Franklin, chief engineer and a director, is to become technical director of the company on July 1st. Mr. J. B. Bucher, A.M.I.Mech.E., is to succeed him as chief engineer.

DR. ARTHUR PORTER has been appointed to the chair of light electrical engineering, tenable at the Imperial College of Science and Technology, University of London. Dr. Porter has been head of the research division of Ferranti, Ltd., Toronto, since 1949.

HOOVER, Ltd., states that Mr. R. J. Pycock, chief production engineer at the High Wycombe factory, has been appointed technical superintendent of the Meadowbank factory, Sydney, of Hoover (Industries) Pty., Ltd. Mr. D. Hamlyn has been appointed chief production engineer at High Wycombe.

MR. S. H. IRELAND has been appointed general works manager of the Small Heath group of the B.S.A. Company, Ltd., on the retirement of Mr. J. A. T. Dickinson. Mr. Herbert Hopwood, chief designer of B.S.A. Motor Cycles, Ltd., has been appointed chief engineer at the Birmingham works, in succession to Mr. H. Faulkner, who has reached retiring age.

THORN ELECTRICAL INDUSTRIES, Ltd., has announced some changes in the sales organisation of its Atlas lighting division. Mr. E. W. King, formerly Midlands area sales manager, has been transferred to the head office; Mr. R. S. Gowing and Mr. M. J. Donaghy have been appointed area sales managers in North and South London, respectively, and Mr. L. A. Moir will be responsible for dealing with large wholesalers in the London area.

KELVIN AND HUGHES, Ltd., announces the following appointments to the boards of three of its subsidiary companies: Kelvin and Hughes (Aviation), Ltd., Mr. F. W. Bates, Mr. R. W. Dunn, Mr. D. H. Perkins, and Mr. G. Wikkenhauser; Kelvin and Hughes (Industrial), Ltd., Mr. P. J. A. Turner, chief engineer at the Glasgow factory; Kelvin and Hughes (Marine), Ltd., Mr. H. R. Whitfield, chief radar engineer, and Mr. R. M. Stephenson, overseas sales manager.

Business Announcements

BRUCE PEEBLES AND CO., Ltd., Edinburgh, states that its works will be closed for the trades holiday from July 1st to 18th inclusive.

MATTHEW HALL AND CO., Ltd., Dorset Square, London, N.W.1, states that its telephone number has been changed to Paddington 1212.

GEO. ROBSON AND CO. (CONVEYORS), Ltd., Hodgson Street, Sheffield, 3, states that its telephone number has been changed to Sheffield 27463.

INDUSTRIA (BEARINGS), Ltd., states that it has moved its London office and stockroom to 115, Gunnersbury Avenue, Ealing, W.5 (telephone, Acorn 8847).

HIGGS MOTORS, Ltd., Witton, Birmingham, 6, states that its works and offices will be closed for the annual holiday from July 22nd until August 8th.

SIMON-CARVES, Ltd., has opened new Indian head offices at Standard Buildings, 32, Dalhousie Square, South, Calcutta, 1. Mr. N. A. Ross is the company's manager in India.

EDWARDS HIGH VACUUM, Ltd., is the new name of the firm formerly entitled W. Edwards and Co. (London), Ltd. Its address is unchanged at Manor Royal, Crawley, Sussex.

JOHN LAING AND SON, Ltd., states that a productivity team of eleven of its senior executives is spending three weeks in the U.S.A. studying building and civil engineering methods.

FLEXELLO CASTORS AND WHEELS, Ltd., Bath Road, Slough Trading Estate, Bucks, announces the formation of a separate company entitled Flexello Castors (Export), Ltd., to deal with its export business.

PLANNAIR, Ltd., Leatherhead, Surrey, states that its axial fans and blowers are to be manufactured under licence in the U.S.A. by arrangement with the Pesco division of the Borg Warner Company.

LEYLAND MOTORS, Ltd., announces that it has acquired the entire issued capital of Scammell Lorries, Ltd. The firm is to be operated as a wholly-owned subsidiary and Mr. W. E. Pearson will continue as managing director.

A. C. COSSOR, Ltd., announces the formation of Cossor Instruments, Ltd., Cossor House, Highbury Grove, London, N.5, to design and develop new instruments for research and industry. Lord Burghley is the chairman of the new company and Mr. L. A. Woodhead is general manager.

FISHER HUMPHRIES AND CO., Ltd., states that it has vacated Atlas Works, Pershore, and has transferred its main business to Pottery Lane, Newcastle upon Tyne, 1 (telephone, Newcastle 28291). Enquiries about spares should be sent to Fisher Humphries and Co., Ltd., Pinvin Works, Pershore, Worcs. (telephone, Pershore 253).

DAVID BROWN AND SONS (HUDDERSFIELD), Ltd., states that a presentation has been made to Mr. Arthur Sykes, Wh.Ex., M.I.Mech.E., technical director, to mark the completion of fifty years' service with the company. During that period, Mr. Sykes has held successively the positions of chief engineer, works manager, engineering controller and technical director.

THE MARCONI INTERNATIONAL MARINE COMMUNICATION COMPANY, Ltd., states that Mr. H. C. Van de Velde is retiring at the end of the month from his position as deputy to the managing director. He will continue to represent the company on the boards of various associated companies overseas. Mr. Van de Velde joined Marconi's Wireless Telegraph Company, Ltd., in 1919.

HAMWORTHY ENGINEERING, Ltd., announces that, under a recently concluded licence agreement with the New York Air Brake Company, Cleveland, Ohio, it is now manufacturing a complete range of "Hydreco" hydraulic equipment for the British market. Two bays of the company's new factory at Fleets Corner, Poole, have been allocated to the new Hydraulics Division and have been equipped to manufacture hydraulic pumps, motors and control valves on a batch production basis.

Contracts

DAVID BROWN MACHINE TOOLS, Ltd., Manchester, has received an order, valued at about £67,000, to supply a turbine gear hobbing machine to Ishikawajima Heavy Industries Company, Ltd., Tokyo.

THE ENGLISH ELECTRIC COMPANY, Ltd., has received an order from the Central Electricity Authority for two 200MW turbo-alternators for the new power station at High Marnham, on the River Trent.

VICKERS-ARMSTRONGS, Ltd., has received an order from British Overseas Airways Corporation for twelve "Viscount" propeller-turbine aircraft. K.L.M. Royal Dutch Airlines has placed an order for nine "Viscounts."

THE TORONTO TRANSIT COMMISSION has placed an order with the Gloucester Railway Carriage and Wagon Company, Ltd., for thirty-four additional cars for the Toronto Rapid Transit Subway. The traction motors, batteries and auxiliary supply equipment will be provided by Crompton Parkinson, Ltd.

THE SHAW SAVILL LINE has placed orders for four fast general cargo liners for service in the New Zealand and Australian trade of the company. All four will be single-screw motorships having a length overall of 480ft, by 64ft beam by a depth to shelter deck of 39ft, a deadweight of 8900 tons and a service speed of 16½ knots. The tenders called for fixed prices and early delivery and three ships are to be built at the Bremen yards of Bremer Vulkan and one at the Govan yard of Harland and Wolff, Ltd.

THE FRASER AND CHALMERS ENGINEERING WORKS of The General Electric Company, Ltd., has received orders from the G. and T. Earle group of the Associated Portland Cement Manufacturers, Ltd., for limestone crushing plant and a shale crushing plant for the Cauldon project in Staffordshire.

JOHN THOMPSON Ltd., Wolverhampton, has been awarded a contract by the United Kingdom Atomic Energy Authority (Industrial Group) in connection with the Dounreay Nuclear Power Station which is the first "fast breeder" reactor to be built in the United Kingdom as a full-scale experimental model capable of producing power. The contract involves the development in collaboration with the United Kingdom Atomic Energy Authority of methods of fabrication for the liquid metal circuits, the design of complete steam and water equipment, the manufacture of the whole of the fusion-welded stainless steel vessels, liquid metal pipelines, primary and secondary heat exchangers, boiler drums and of the associated plant, valves and instrumentation, together with the feed water treatment plant. The Company has developed a separate department to deal with this contract, and manufacture has begun.

Miscellanea

STATISTICAL CONFERENCE.—The first European Conference on Statistical Quality Control, which is sponsored by the European Productivity Agency of the Organisation for European Economic Co-operation, will be held in Paris on July 11th, 12th and 13th.

ROYAL INSTITUTION OF CHARTERED SURVEYORS.—At a recent meeting of the Council of the Royal Institution of Chartered Surveyors, Mr. William R. Brackett was elected president and Mr. W. E. A. Bull senior vice-president. Three other vice-presidents were elected as follows: Mr. W. M. Balch, Mr. F. G. Fleury and Mr. J. L. Postlethwaite.

ELECTRICALLY HEATED FLATS AT KIRKCALDY.—We have received from the South of Scotland Electricity Board, a brochure describing the eight-storey block of flats recently completed at Kirkcaldy. These flats are run entirely on electricity. A system of under-floor heating has been installed, and there are off-peak electric storage systems for hot water.

ALUMINIUM DIRECTORIES.—We have received from the Aluminium Development Association, 33, Grosvenor Street, London, W.1, a copy of the *Directory of Members*, which contains a brief statement of the constitution and objects of the Association and a short résumé of the activities and products of each of the member companies. The Association has also published a *List of Publications*, which gives details of the information bulletins, applications brochures, research reports and reprinted papers and articles which are available.

LLOYD'S CONSTRUCTIONAL RULES.—Lloyd's Register of Shipping has issued copies of the amendments to the Society's Rules, including the revised rules for the construction of refrigerated cargo installations. Among the alterations there is a new section which is concerned with ships specially designed for the carriage of ore cargoes—that is, ships with machinery aft, central ore holds and wing tanks for oil or water ballast, and the new class is designated 100 A.1. ore carrier. Provided that the scantlings are suitable, existing ships can qualify for the new class.

STEEL WORKS SHUNTING LOCOMOTIVES.—The first of three 500 h.p. B_0-B_0 diesel-electric shunting locomotives, built to the special requirements of the Steel Company of Wales, Ltd., has been delivered by Brush Bagnall Traction, Ltd. Each of these new locomotives weighs 70 tons and is designed for a maximum speed of 28 m.p.h. and a starting tractive effort of 47,000 lb at 30 per cent adhesion. The power unit consists of a Mirrlees six-cylinder diesel engine, developing 515 h.p. at 875 r.p.m., coupled to a Brush self-ventilated, compound-wound, main generator.

OIL PIPELINE IN VENEZUELA.—We are informed that a pipeline, 45 miles long, has been completed for the Compania Shell de Venezuela to link the company's concessions in Lake Maracaibo with the loading terminal at Palmarejo. The pipeline, known as the Lapline, consists of two sections, the first, 16in in diameter and 18½ miles long, starts, in 70ft of water, from a platform set up in the lake and comes ashore at La Ensenada, where it is joined to the second section, which is 24in in diameter and terminates in Palmarejo. The rated capacity of the line is 100,000 barrels per day.

DIESEL-ELECTRIC PADDLE TUGS.—The Admiralty has announced that paddle-driven tugs have been found to be the most suitable for moving aircraft carriers and other large warships in the confined waters of dockyard basins. Seven such tugs are to be built and the new craft will have a length between perpendiculars of 145ft by 58ft breadth over sponsons and a moulded depth of 15ft. Four Paxman diesel engines will drive the B.T.H. generators supplying the power for the two B.T.H. motors, which will drive the paddle shafts through Renolds chain gearing with a reduction ratio of 8 to 1. The tugs will operate as fire-fighting craft, a 150 tons per hour pump being fitted, and there will be four standard Foden diesel generators. Two tugs have been ordered from Yarrow and Co., Ltd., and two from William Simons and Co., Ltd.

British Patent Specifications

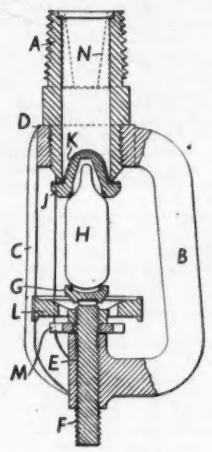
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. 8d. each.

FIRE EXTINGUISHING APPARATUS

731,200. March 3, 1953.—AUTOMATIC WATER SPRINKLERS, Fire Armour Limited, 9, George Street, Baker Street, London, W.1. (*Inventor: Albert James Norton.*)

According to the invention, the sprinkler device comprises a ½in nozzle *A* threaded for attachment to a water supply pipe, and at the lower end attached to a three-armed yoke, two of which arms are shown at *B* and *C*. These arms are integral with a ring *D*, while the lower ends are integral with a boss, *E*. A screw *F* is threaded through the boss, and on its upper end it carries an annular holder *G*, which



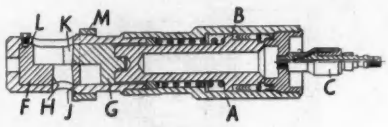
No. 731,200

supports the frangible glass bulb *H*. The upper end of the bulb is pressed against a coned shaped closure member *J* with a copper lining *K*, making a water-tight joint, with the nozzle. The upper end of the screw *F* also carries an annular deflector plate *L*, the upper side of which has a shallow depression. The plate has drilled in it a number of holes which lead from the coned surface of the plate. Below this deflector plate is a further deflector plate *M*, which has radial notches corresponding to the holes in the upper plate. When in use the glass bulb bursts at a pre-determined temperature leaving a completely unobstructed passage for the water stream issuing from the nozzle. The holder *G* is blown away. A small quantity of water is projected upwards above the sprinkler. The apertures in the deflector plate *L* pass only about 25 per cent of the remaining water, and the other 75 per cent is deflected laterally upwards to form a curtain of water in the form of an umbrella or annular diverging curtain. The water which passes through the holes in the plate mainly strikes the peripheral part of the lower deflector plate and forms a spray cone more or less vertically downwards through the notches in the lower plate. In situations where a very fine spray is desirable or where the water pressure is very poor, a venturi tube *N*, can be inserted in the nozzle, the effect being to reduce the output by 25 per cent but a finer spray is produced.—*June* 1, 1955.

TOOLS AND WORKSHOP APPLIANCES

730,962. January 11, 1952.—APPARATUS FOR SHEARING METAL RODS OR BARS, The Hydraulic Engineering Company Limited, Charles Street, Chester, and Arthur Rivington Magnall, Christleton Grange, near Chester.

The drawing shows a portable cropping apparatus for round rods or bars of relatively small section and comprising a casing in the form of a cylinder *A* in which is movable a ram *B* under hydraulic power supplied from an inlet member *C*. Within the cylinder are two dies *F* and *G*, one of which, *F*, is fixed while the other, *G*, is movable by the ram. Each of the dies is of substantially "L" shape, the base of the "L" in each case being of circular or polygonal shape in cross-section to correspond to the cross-sectional shape of the bore of the cylinder so that such parts of the dies thus fit closely within and are entirely backed by the wall of the cylinder bore. The limb of each die is of semi-circular or other shape to suit the shape of the bore. The fixed die has a coned aperture *H* through the limb in register with an aperture *J* in the wall of the cylinder so that the rod or bar to be cropped may be pushed through and engaged in a concave oppositely semi-coned end *K* on the movable die. The shape of the aperture in one die and of the concave end of the other die are made to suit the shape of rod or bar to be cropped. In the opposite cylinder wall to the aperture *J* there is a further aperture *L*, the end of which



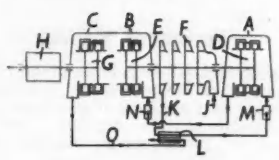
No. 730,962

on the side of the movable die is aligned with the corresponding end of the aperture *J*, the length of which in the axial direction is twice that of the corresponding length of the aperture. When the rod or bar has been inserted an anvil or abutment quick-threaded screw ring *M* operating over half of the circumference of the outer wall of the cylinder may be spun round by hand so as to contact the bar to prevent it tilting during the shearing operation by the movable die when power is applied to the ram. Modified designs are also shown in the specification.—*June* 1, 1955.

GAS TURBINES

730,834. June 1, 1953.—GAS TURBINE INSTALLATIONS, Maschinenfabrik Oerlikon, Oerlikon near Zürich, Switzerland.

The invention relates to gas turbine installations with a gas turbine driven air compressor. As will be seen in the drawing, there are three turbines, *A*, *B* and *C*. The rotors *D* and *E* of the axial flow turbines *A* and *B* respectively, are overhung upon the two shaft ends of the compressor *F*. Similarly, the rotor *G* of the turbine *C* is overhung upon a shaft end of the generator *H*. The compressor draws in



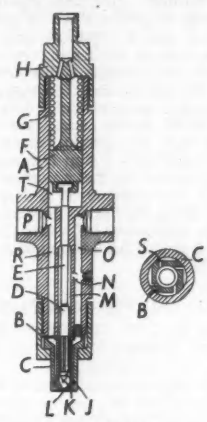
No. 730,834

air through the nozzle *J* and delivers it through the nozzle *K* to the heat exchanger *L*, and further to the combustion chamber *M*. From the combustion chamber, gases at high temperature flow into the turbine *A* where they expand and subsequently flow to the combustion chamber *N*. Gases at high temperature again leave the combustion chamber, and pass into the turbine *B*. Thence the gases flow directly into the turbine *C*, which drives the generator *H*, as the effective output turbine. After the exit from the component turbine C the exhaust gases flow through the pipe *O* to the heat exchanger *L*, and subsequently to atmosphere. In this arrangement, each of the three turbines has two rotor wheels arranged in overhung fashion, and the turbine *B* driving the compressor *F* on one side is housed in a common housing with the effective output turbine *C* driving the generator *H*. Thus it is possible to achieve short structural length and low costs of production of the installation.—*June* 1, 1955.

BURNERS AND SPRAYERS

730,843. August 17, 1953.—LIQUID FUEL ATOMISERS, John Francis Butler, Cuthbert Coulson Pounder and Sir Frederick Ernest Rebbeck, all of Harland and Wolff Limited, Queen's Island, Belfast, Northern Ireland.

According to the invention, a liquid fuel atomiser of the spill type, particularly for boiler or gas turbine combustion chambers, has the liquid fuel discharge orifice controlled by a valve member which is opened by the pressure difference between the inlet fuel pressure and spill pressure. The valve member is carried by a valve spindle which is acted upon by a push rod connected to a spring-loaded piston subjected to the fuel inlet pressure acting against the spring-loading of the piston so that, when fuel is being supplied to the atomiser, the piston holds the push rod clear of the end of the valve spindle and the valve member is free to open the fuel discharge orifice. As shown in the drawing, an atomiser body *A* has at one end an inner sleeve *B* surrounded by an outer sleeve *C* secured to the body by a cap nut. A valve spindle *D* is actuated by a push rod *E* connected to a piston *F* loaded by a spring *G* held in place by a cap nut *H*. The valve member comprises a conical head *J* terminating in a pintle *K* which substantially fills the fuel discharge orifice *L* in the end of the sleeve *B*, which is formed as a conical valve seat. The valve head is connected to the spindle by a plug reciprocable in the sleeve and straight grooves in the circumference of the plug form spill passages connecting the fuel space around the valve head with an axial spill chamber *M* in the atomiser body around the spindle *D*. The spill chamber communicates through a port *N* with a spill outlet passage *O*. Fuel is admitted under pressure to the atomiser through a connection *P* into a passage *R* in the atomiser body and into spaces between the sleeves *B* and *C*. The sleeve *B* is of substantially square outer cross-section and has transverse ports *S* which allow the fuel to pass from



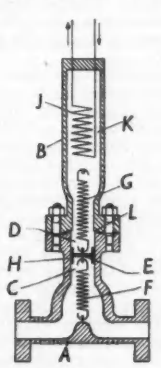
No. 730,843

the spaces between the sleeves into a chamber around the valve head *J* and through the passages formed by the grooves in the plug into the spill passage *M*. The transverse ports *S* are tangential to the inner cylindrical surface of the sleeve so that the fuel enters the space around the valve head with a swirling motion. At the same time some of the fuel entering the atomiser body passes into a space *T* in front of the piston *F* and pushes it outwards against the action of the spring which is housed in a chamber open to the atmosphere through passages in the cap nut *H*. The valve head is thus free to move away from the valve seat under the action of the differential pressure caused by the pressure of the fuel in the space around the valve head and the lower pressure of the fuel in the spill passage *M*. When the fuel supply to the atomiser is cut off, the pressure fall in the space *T* causes the spring to press the piston and push rod forwards until the rod strikes the spindle and presses the valve head on to the valve seat, when the pintle *K* enters the fuel discharge orifice *L*.—*June* 1, 1955.

PUMPS

731,031. July 10, 1953.—DAMPING PULSATING PRESSURE IMPULSES IN PIPES, Sulzer Freres Societe Anonyme, Winterthur, Switzerland.

The invention relates to apparatus for damping pulsating pressure impulses in pipes communicating with a piston feed pump for a steam boiler, and is of the kind in which the liquid acts through a connecting tube against a vapour cushion produced by vaporisation of a liquid in a chamber with which the connecting tube communicates. As shown in the drawing a pipe *A* for conveying a liquid, for instance water, is connected to a source of pulsating pressure impulses, such as the suction side or to the delivery side of a piston feed pump. For relieving the pulsating pressure impulses a tube *B*, which is closed at its upper end, is connected to the pipe and contains the same liquid. The water content of the tube *B* is separated into two bodies *C* and *D* by a piston *E*, suspended between springs *F* and *G* which tend to hold it in a central position. These springs permit the piston to move upwards or downwards to an extent proportional to the magnitude of the pressure impulses acting on it. The central position of the piston can also be determined by a weight load on one side of the piston and by a spring on its other side. The piston is a slack fit in the connecting tube *H* in which it lies, so that there is a restricted passage through which water can flow past it, from the body *C* to the body *D*, or vice versa. The water *D* above the piston is heated by a steam



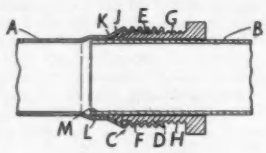
No. 731,031

coil *J* projecting into the upper zone *K* of the tube. If steam of a higher temperature than the boiling point of the water in the zone *K* flows through the heating coil *J*, steam is thus generated and depresses the water level around the heating coil until the pressure of the liquid passing through pipe *A* again exceeds the pressure of the steam cushion generated in the zone *K*. The heating of the steam cushion so formed exerts also a pressure on the piston *E*, against which acts the pressure exerted on the other side of the piston by the water passing through the pipe *A*. The heating of the steam cushion should in general be sufficient only to compensate for heating losses to the outside. Normally the pressure of a boiler feed pump is greater than the pressure of the steam generated and is therefore greater than the pressure of the steam in the heating coil *J*, which may be taken from a superheater. Thus in the event of a fracture of the heating coil feed water could enter the superheater in large quantities through the heating coil unless special means were taken. In order to avoid this risk, the interior of the connecting tube *H* is provided with a stop *L* against which the piston will be forced by the water pressure in the pipe *A* should the pressure of the steam cushion fall too low. Thus, the piston acts as a non-return valve whereby penetration of water from the pipe into the zone and into the heating coil is prevented.—*June* 1, 1955.

TUBE AND PIPE COUPLINGS

731,319. April 14, 1953.—PIPE JOINT, Dreh Patents, Ltd., 4–5, Holborn Circus, London, E.C.1. (*Inventor : Donald Rudd.*)

The invention relates to pipe joints of the spigot and socket type, and joints in pipes or tubes comprising screw engageable parts to make and complete the joint. Its object is to provide a simple and effective fluid-tight joint. In the drawing the end portion of a pipe *A* of two pipes *A* and *B* to be joined is expanded to



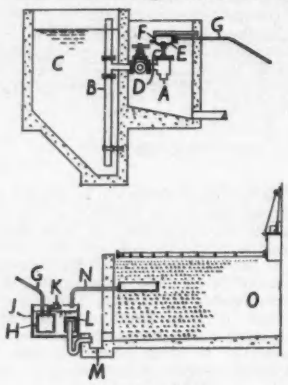
No. 731,319

produce a socket generally indicated at *C* of larger diameter than, and coaxial with, the pipe proper, the wall *D* of the socket being deformed in the way described in Specification No. 719,143 to a zigzag sinuous form in cross-section so that it has an internal screw thread *E* and an external screw thread *F*. A sleeve *G*, having an external screw thread *H* matching the screw thread *E* so that it may be screwed into the socket, fits freely over the second pipe *B*. The pipe *B* is surrounded by a deformable sealing ring *J* pressed by the sleeve against the internal shoulder *K* constituted by a flare of the socket. It will be seen that behind the flare or shoulder *K* there is a short portion *L* of pipe of larger internal diameter than the external diameter of the inner pipe, providing accommodation for a portion *M* of the inner pipe *B* extending into the socket beyond the shoulder. An alternative form for the inner pipe *B* is also shown in the specification.—*June* 8, 1955.

CIVIL ENGINEERING

731,289. September 25, 1952.—REMOVING SLUDGE FROM SEDIMENTATION TANKS, Charles Robert Barrington Brown, 28, Welbeck Avenue, Hove, Sussex, formerly of 36, Prince George Avenue, Southgate, London, N.14.

The invention relates to automatic apparatus for discharging sludge from sedimentation tanks and is particularly applicable in connection with installations for the purification of sewage or other foul liquids. The upper view shows the general arrangement of the automatically operated valve in conjunction with sludge pipes of a sedimentation tank, and the lower view the siphon cistern containing the air bell fitted with a non-return valve and a pipe connecting to the diaphragm casing of the sludge valve, also the pipe supplying the siphon cistern with a proportional flow of the liquid passing to the filter from a distributing apparatus which may be either fixed or moving. An alternative device for operating the sludge valve in which the air bell is housed in a tipping vessel and is provided with a flexible connection to the pipe connecting to the sludge valve, is also shown in the specification. *A* is the automatically operated sludge valve fixed on the outlet of the sludge pipe *B* in the sedimentation tank *C*. *D* is the link or spindle connecting the valve door or flap to the flexible diaphragm *E* fitted to the housing or casing *F*. *G* is the connecting pipe to the operating air bell *H* in the automatic siphon cistern *J*. *K* is the non-return valve for liberating the air in *H* as the liquid level rises in cistern *J*. *L* is the siphon for automatically discharging the liquid contents of the cistern when a determined level is reached into the filter effluent collecting channel *M*. *N* is the



No. 731,289

supply pipe to the cistern connecting to a collecting tray inserted in the filter *O*. It will be seen that the sewage or other liquid is first passed through a sedimentation tank and thence through a percolating filter, apparatus for intermittently discharging sludge from the sedimentation tank comprising a valve on the sludge discharging pipe automatically opened and closed for the purpose by a suitable pneumatic device, the supply of working pneumatic fluid to which is controlled by a fractional portion of the liquid flow passing to the filter.—*June* 8, 1955.

Technical Report

"*L'exploitation des Données Empiriques.*" *Actes du Colloque Tenu à Luxembourg, en Juillet* 1953, *dans le Cadre du Congrès de L'Association Française pour l'Avancement des Sciences.* Publications Scientifiques et Techniques du Ministère de l'Air, No. N.T.52. Paris : Sdit, Magasin C.T.O.: 2, Avenue de la Porte-d'Issy, Paris (15*e*). Price Fr. 850.—The seven monographs of which this book consists were submitted at the 1953 congress of the French Association for the Advancement of Science. The papers deal with the evaluation of observational data and their representation in the form of mathematical laws. In the first, M. S. Arend shows how by means of Cracovian matrices, using the principle of least squares, one can determine a Lagrange polynominal for interpolation and extrapolation of the data, and for calculating the residuals. M. Dommanget, in the first of his two papers, describes the practical procedures required for determining the parameters of the function $a+bf(x, \alpha)$ according to the principle of least squares, and shows how the calculations are carried out in the case of the exponential function. In his second paper the author deals with the fitting of a straight line when one of the two variables is known exactly, and also when it is not so known, and goes on to consider the procedures appropriate when the data follow an exact law, and those applicable when there is only a correlation. The fourth and fifth memoirs are by M. Schmitt. In them the author describes a representative exponential and also a homographic representation which, without considering least squares, represent all the data in as homogeneous a form as possible. In the next paper M. Ziller discusses the numerical integration of the second order differential equation which arises in the problem of a vibrating non-homogeneous string fixed rigidly at one end, and elastically at the other. The result is obtained as a power series, of which the coefficients are given up to and including the term of eleventh degree. The final paper is by M. Vernotte, who remarks that an experimental curve is never obtained for its own sake, but for the information it gives concerning the parameters in terms of which the physical quantities are expressed. The method of "least squares" gives the curve which best fits the data, but is not necessarily the best method for determining a property of that curve. If, instead of a statistical property of the experimental errors, one uses the condition that the influence of those errors should be a minimum, one obtains a completely defined solution. One could, simply from conditions of goodness of fit, obtain a curve which then would give the "best" result for the parameters required. However, such a procedure, although elementary, is of such arithmetical complication that a calculating machine has to be used.

Launches and Trial Trips

CRETIC, cargo liner ; built by Swan, Hunter and Wigham Richardson, Ltd., for Shaw Savill and Albion Company, Ltd.; length overall 512ft 0½in, length between perpendiculars 481ft, breadth moulded 69ft, depth moulded to upper deck 33ft 4½in, draught loaded 30ft 4½in., deadweight 11,480 tons, service speed 17 knots, refrigerated cargo capacity 333,430 cubic feet, general cargo capacity 303,890 cubic feet ; two complete steel decks, six holds, derricks to lift 5, 7 and 12 tons, also one to lift 25 tons and one to lift 70 tons, electric deck machinery, two 480kW and two 200kW diesel-driven generators and one 75kW diesel-driven emergency generator ; two vertical boilers ; two six-cylinder Wallsend-Doxford single-acting, two-stroke opposed piston oil engines, cylinders 670mm diameter by 2320mm combined stroke, total power 12,860 b.h.p. at 114 r.p.m. Trial, May 26th.

KEIZERSWAARD, oil tanker ; built by the Netherlands Dock and Shipbuilding Company for N.V. Verenigde Nederlandse Tankvaart Rederij ; length between perpendiculars 532ft 6in, breadth moulded 72ft 9in, depth 38ft 3in, summer draught 29ft 6in, deadweight 18,500 tons, trial speed 15·5 knots ; twenty-seven oil cargo tanks ; Stork single-acting, supercharged two-stroke diesel engine, eight cylinders, 750mm diameter by 1500mm stroke, 8500 b.h.p. at 117 r.p.m. Launch, June 4th.

NORMAN PRINCE, fruit carrier ; built by the Burntisland Shipbuilding Company, Ltd., for the Prince Line, Ltd.; length between perpendiculars 313ft, breadth 46ft 3in, depth moulded to shelter deck 27ft 9in, deadweight 3500 tons ; twelve passengers ; six 5-ton derricks and one 25-ton derrick, steam deck machinery ; Ailsa-Doxford opposed-piston oil engine, three cylinders 560mm diameter by 2160mm combined stroke, 2300 b.h.p., one multitubular boiler and one vertical boiler. Launch, June 6th.

WOOLWICH, cargo liner ; built by the Caledon Shipbuilding and Engineering Company, Ltd., for the Britain Steamship Company, Ltd.; length overall 465ft, breadth 58ft 6in, depth 38ft, five cargo holds, 10-ton and 5-ton derricks, steam deck machinery ; three 100kW diesel-driven generators ; Stephen-Doxford oil engine, four cylinders 670mm diameter by 2320mm combined stroke, Bibby detuner flywheel. Trial, June 6th.

NAREK, oil tanker ; built by the Blythswood Shipbuilding Company, Ltd., for the Baltic Trading Company, Ltd.; length between perpendiculars 552ft, breadth moulded 75ft, depth moulded 40ft, deadweight 20,000 tons ; ten centre and fourteen wing cargo oil tanks, two cargo pump rooms, four 500 tons per hour cargo oil pumps ; two single-ended cylinder boilers ; David Rowan and Co., Ltd., supplied one set of double-reduction geared Parsons turbines, 8700 s.h.p. at 100 propeller r.p.m., steam supplied at 450 lb per square inch and 750 deg. Fah. by two oil-fired Foster Wheeler forced draught water-tube boilers. Launch, June 8th.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

CHEMICAL SOCIETY

Wed. to Fri., July 13th to 15th.—The University College of the South West of England, Prince of Wales Road, Exeter, Symposium on "Recent Work on Naturally Occurring Nitrogen Heterocyclic Compounds."

INSTITUTE OF BRITISH FOUNDRYMEN

To-day and Sat., June 24th and 25th.—LONDON : Twenty-second International Foundry Congress.

INSTITUTE OF PETROLEUM

Thurs., June 30th.—Institution of Mechanical Engineers, 1, Birdcage Walk, London, S.W.1, Four papers outlining "The Story of the Co-ordinating Research Council," by M. K. McLeod, T. B. Rendel, E. S. Macpherson and W. J. Sweeney, 3.30 and 5.30 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

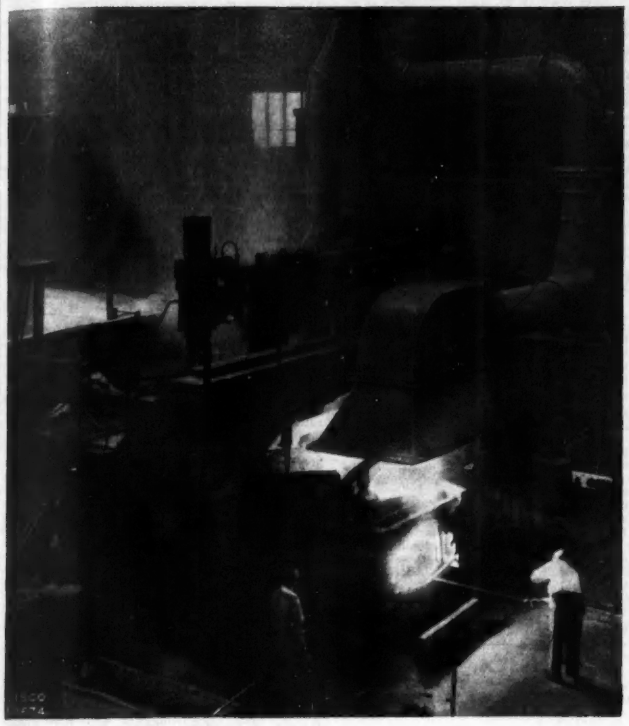
Fri., July 1st.—Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, Annual General Meeting, followed by Film, "Highways for To-morrow," 5.30 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Mon. to Sat., July 11th to 16th.—The University, Edgbaston, Birmingham, 15, Seventy-Fourth Annual Meeting.

END OF VOL. 199

Photo by courtesy of Messrs. Thos. Firth & John Brown Ltd.



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THE ENGINEER

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Advertisements received by Mid-day Tuesday will appear in the issue of Friday the same week. Orders must be accompanied by a remittance.

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PUBLIC APPOINTMENTS

UNIVERSITY COLLEGE OF SWANSEA

APPOINTMENT

Applications are invited for a Probationary Assistant Lectureship or a Lectureship in either Civil Engineering or Mechanical Engineering.

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Further particulars may be obtained from the Registrar, University College, Singleton Park, Swansea to whom applications must be sent by Thursday, June 30, 1955. E5376

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Salary according to qualifications and experience will be within the range £900 to £1500 per annum inclusive of cost-of-living allowance. Salary scales are at present being reviewed and range shown may be subject to increase.

Full particulars may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1, or from the undersigned.

Closing date for applications is 10th October, 1955.

JOHN H. M. OMOND,
Secretary,
Engineering Board of Management,
Box 197E, G.P.O., Hobart, Tasmania. E5511

AUSTRALIA

UNIVERSITY OF MELBOURNE

SENIOR LECTURER IN MECHANICAL ENGINEERING

Applications are invited for the position of SENIOR LECTURER IN MECHANICAL ENGINEERING.

The salary will be £A1,750-£A2,000, according to qualifications. Superannuation is similar to F.S.S.U.

Applicants should possess a University Degree in Mechanical Engineering, and experience in industrial or production engineering is a desirable qualification.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

The closing date for the receipt of applications, in Australia and London, is August 15th, 1955. E5486

UNIVERSITY OF LONDON, KING'S COLLEGE

RESEARCH STUDENTSHIP

University of London, King's College offers a RESEARCH STUDENTSHIP, made available by British Insulated Callender's Cables, Ltd., and tenable for one year, with possible renewal for a second year. The value will be between £350 and £400 p.a. The Studentship is for research into the mechanical properties of powdered materials in relation to their use as electrical insulators. The character of the research is such that it should lead to a Higher Degree.

Applicants should have a good Honours Degree in Engineering or Physics. Particulars and application forms from the Registrar, King's College, London, Strand, W.C.2, whom completed forms must reach by July 14th. E5527

PUBLIC APPOINTMENTS

WEST AFRICAN INSTITUTE

FOR OIL PALM RESEARCH, NIGERIA

RESEARCH ENGINEER

Applications are invited for the post of RESEARCH ENGINEER at the West African Institute for Oil Palm Research.

Duties are primarily research and development in connection with engineering problems, particularly those arising in the processing of oil palm fruit in plantation oil mills of various kinds. The officer will be required to work in close collaboration with other members of the Institute staff concerned with the production of the crop in the field and will be required to modify existing plant or design new.

Appointment is either pensionable or on contract in the gross salary range £1172 10s. to £2037 10s. p.a. with a gratuity of £122 to £275 10s. p.a. in the case of a contract appointment.

Free passages are provided for the officer, his wife and all children under 13 years of age. Furnished Government quarters are provided, if available, at a rental of 10 per cent. basic salary, subject to a maximum of £150 per annum. Leave is granted at the rate of seven days for each completed month of resident service.

Candidates, not less than 26 years of age, should hold a good Honours Degree in Mechanical or Chemical Engineering and have had at least three years' post graduate experience in the design and operation of plant for vegetable oil extraction and processing. They must possess a "research outlook" and should be well versed in the critical appreciation of practical problems from a scientific angle. They must be well qualified engineers with a particular aptitude for mechanical matters, and have a good knowledge and experience of chemistry.

Apply in writing to the Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, giving briefly age, qualifications and experience. Mention the reference number BCD 197/199/0. E5431

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE

Principal : H. BAKER, Ph.D., A.M.I.C.E., A.M.I.Mech.E.

DEPARTMENT OF MECHANICAL ENGINEERING

ASSISTANT LECTURER, GRADE B

Applications are invited for the post of ASSISTANT LECTURER, Grade B, in the Department of Mechanical Engineering. Preference will be shown to applicants having an Engineering Degree and/or Corporate Membership of the Institution of Mechanical Engineers. Previous teaching experience will be an added recommendation. The successful candidate will be required to teach some of the following subjects to H.N.C. or Degree standard : Strength of Materials, Theory of Machines, Applied Thermodynamics, Mechanics of Fluids.

Salary : £525 by £25 to £820 per annum, together with Degree and training allowances in appropriate cases.

Application forms and further particulars may be obtained from the Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham, to whom completed forms should be returned not later than 8th July, 1955.

F. STEPHENSON,
Clerk to the Joint Education Committee.
16th June, 1955. E5436

WARWICKSHIRE COUNTY COUNCIL

TECHNICAL COLLEGE AND SCHOOL OF ART, NUNEATON

Principal : W. HOWARD JOINT, M.A. (Oxon)

ASSISTANT, GRADE B

Required as soon as possible, ASSISTANT, Grade B, to teach mainly Heat Engines and Hydraulics up to Higher National Certificate. Ability to teach one or more of the following at advanced level an advantage : Theory of Structures, Theory of Machines or Workshop Technology. Salary in accordance with the Burnham Technical Report, i.e. for men : £525 by £25 to £820, with additions for Degree or equivalent, training, industrial experience and teaching service.

Further particulars and forms of application may be obtained from the Principal, Technical College and School of Art, Coton Road, Nuneaton, and should be returned not later than the 11th July, 1955.

N. A. Y. YORKE-LODGE,
E5530 County Education Officer.

NORTH GLOUCESTERSHIRE TECHNICAL COLLEGE, CHELTENHAM

ASSISTANT LECTURER (GRADE B)

Applications are invited from suitably qualified persons for the post of ASSISTANT LECTURER (Grade B), to take Mechanical Engineering subjects to Ordinary and Higher National Certificate level.

Salary scale, £525 per annum, rising to £820 per annum, plus allowances for Degree and/or recognised training. In fixing the commencing salary recognition will be given for approved industrial experience over the age of 21.

Forms of application which can be obtained from the Clerk to the Governors, should be returned to him within ten days of the appearance of this advertisement. E5466

PUBLIC APPOINTMENTS

BOURNEMOUTH EDUCATION COMMITTEE

BOURNEMOUTH MUNICIPAL COLLEGE OF TECHNOLOGY AND COMMERCE

LECTURER

LECTURER required to teach mechanical engineering subjects up to the standard of the Higher National Certificate and the External London B.Sc. Degree. Applicants should have an Honours Degree in Mechanical Engineering or an equivalent qualification. Both industrial and teaching experience are required.

GRADE "B" ASSISTANT required to teach mechanical engineering subjects to the standard of S3 Ordinary National Certificate. Applicants should have a Degree in Mechanical Engineering or equivalent qualification. Both industrial and teaching experience are desirable.

Salaries for both posts according to the Burnham Technical Scale, 1954.

Further particulars and application forms obtainable from W. R. Smedley, Chief Education Officer, Town Hall, Bournemouth, returnable by 8th July. E5479

DORSET COUNTY EDUCATION COMMITTEE

SOUTH DORSET TECHNICAL COLLEGE

APPOINTMENTS

Applications are invited for the following posts :—

ASSISTANT, Grade B, in Motor Vehicle Engineering and Allied Subjects, to teach up to Final City and Guilds Certificate standard. Candidates should hold a Full Technological Certificate in Automobile Engineering or its equivalent, with good industrial and teaching experience.

METALWORK TEACHER.—Candidates should hold a Teacher's Handicraft Certificate in Metalwork and will be required to teach practical metalwork and ancillary subjects to G.C.E. standard, mainly in the Secondary Technical School.

Forms of application may be obtained from the Principal, South Dorset Technical College, Newstead Road, Weymouth (s.a.e.), and should be returned to him within 14 days of the appearance of this advertisement. E5388

ESSEX

THURROCK TECHNICAL COLLEGE

ASSISTANT GRADE B

Required in September, if possible, for this new College opening then, ASSISTANT GRADE B with full Technological City and Guilds Certificate in Machine Shop Engineering.

Salary £525 by £25 to £820 with additions for approved qualifications and training and increments for previous teaching service and approved experience.

Forms and details (S.A.E.) from Chief Education Officer, County Offices, Chelmsford. E9996

MIDDLESBROUGH EDUCATION COMMITTEE

CONSTANTINE TECHNICAL COLLEGE

LECTURER

Applications are invited for the appointment of LECTURER in the Department of Structural Engineering, commencing as soon as possible, to teach Design and Theory of Structures to Higher National Diploma standard. Ability to teach one or more of Surveying, Mechanics of Fluids, Geology and Soil Mechanics is desirable. Salary, £965 by £25 to £1065.

Forms and particulars are obtainable from Director of Education, Woodlands Road, Middlesbrough, to whom applications should be returned by Friday, 1st July, 1955. E5455

LONDON COUNTY COUNCIL

WANDSWORTH TECHNICAL COLLEGE

ASSISTANT GRADE A

Wandsworth Technical College, September, 1955 —ASSISTANT, Grade A, to teach Sheet Metal Work, Theory and Practice, to Final City and Guilds standard. Appropriate qualifications, industrial and teaching experience desirable. Burnham salary scale varies between £486 and £917. Individual minimum and maximum according to age, qualifications and experience. Application forms from Secretary at College, Wandsworth High Street, S.W.18, returnable by 9th July. (930) E5393

THE COLLEGE OF AERONAUTICS

DESIGN DRAUGHTSMAN

DESIGN DRAUGHTSMAN required for work on special plant and equipment associated with aeronautical research and development work. Previous experience and electrical knowledge an advantage, but not essential. H.N.C. or equivalent preferred. Five-day week. Four weeks' leave a year, excluding Bank Holidays. Salary range £650–£750 per annum, depending on age, qualifications and experience.—Application forms from Chief Clerk, The College of Aeronautics, Cranfield, Bletchley, Bucks. E5426

PUBLIC APPOINTMENTS

LONDON COUNTY COUNCIL

WESTMINSTER TECHNICAL COLLEGE

LECTURER

Westminster Technical College, September, 1955. LECTURER for Department of Civil Engineering. Should be engineering Graduates or Members of a professional Institution and prepared to teach Theory and Design of Structures, Soil Mechanics to Higher National Certificate standard. Burnham salary scale, £1001 to £1113. Application form from Principal at College, Vincent Square, S.W.1, returnable by 9th July. (865). E5394

SOUTH AFRICAN BUREAU OF STANDARDS

METALLURGIST

Applications are invited from suitably qualified persons for appointment as METALLURGIST. Applicants should hold at least a B.Sc. Degree with Chemistry and/or Metallurgy as a major subject, or an equivalent qualification. Experience in metallurgical analysis and a knowledge of the metallurgy of iron and steel will be a recommendation.

The salary scale is £1020 by £60 to £1380, plus a cost-of-living allowance of £234 per annum in the case of married officers.

It is obligatory to become a member of the provident fund, which involves a contribution of 7 per cent. of basic salary and a similar contribution by the Council of the South African Bureau of Standards.

The successful applicant will be appointed on contract basis for three years and will be paid his salary as from the date of embarkation, plus cost of rail and second-class boat fares for himself and immediate family. Should the successful applicant terminate his contract within a period less than three years he will be required to refund a pro rata proportion of the expenses incurred in bringing him and his family to South Africa. After the expiry of the three years' contract period the successful applicant will be on the Bureau's staff subject to the normal conditions of employment. In addition, the successful applicant will, after three months' service with the Bureau, also be entitled to claim a refund of 50 per cent. or £60, whichever is the lesser (in the case of married officers), or 50 per cent. or £20, whichever is the lesser (in the case of single officers), of the cost of transporting his furniture and personal effects to Pretoria, such claim to be properly substantiated by receipts.

Applications, giving full details regarding age, marital status, nationality, knowledge of English, scientific and technical qualifications and experience, together with a medical certificate of health and the names of at least two persons to whom reference may be made, must reach the Secretary, South African Bureau of Standards, Private Bag 191, Pretoria, South Africa, before 15th August, 1955. E5420

THE RUBBER RESEARCH INSTITUTE OF MALAYA

KUALA LUMPUR, FEDERATION OF MALAYA

CHEMICAL ENGINEER

The Board of the Rubber Research Institute of Malaya invites applications for the following posts on the staff of the Chemical Division.

CHEMICAL ENGINEER.

To carry out development work to the pilot plant stage for the Chemical Division at Kuala Lumpur and at the R.R.I. Experiment Station, Sungei Buloh. Applicants should have a First or Second Class Honours Degree plus a professional qualification in Chemical Engineering. Experience in the chemical industry is required rather than a knowledge of rubber manufacture.

Appointment will be made on the following salary scale, the point of entry being according to age, qualifications and experience.

Basic salary : $600–$1320 per month (sterling equivalent £840–£1848 per annum) on a time scale. Super scale for appointments of special responsibility $1440–$1920 per month (sterling equivalent £2016–£2688 per annum).

Expatriation pay : At present $190 to $280 per month (sterling equivalent £266 to £392 per annum).

Cost-of-Living Allowance : Depending on point of entry and marital status to a maximum of $350 per month (sterling equivalent £494 per annum).

Form of application and further particulars may be obtained from the Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, London, S.W.7. The closing date for receipt of applications is 30th July, 1955. E5469

MINISTRY OF SUPPLY

NATIONAL GAS TURBINE ESTABLISHMENT

SENIOR SCIENTIFIC OFFICER

SENIOR SCIENTIFIC OFFICER (minimum age 26) required at Ministry of Supply National Gas Turbine Establishment, near Farnborough, Hants., to define instrument requirements for new engine test plant and develop circuits and, where necessary, special instruments for the flow control and temperature measurements of liquids and gases. Qualifications : 1st or 2nd Class Honours Degree or equivalent in Physics or Electrical or Mechanical Engineering. Experience in plant instrumentation, process control and digitisation of readings required and a thorough knowledge of current instrument production necessary. A house may be available for the successful candidate if married. Salary within range £970–£1125 p.a. (superannuable). Women somewhat less.—Application forms from M.L.N.S. Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting A209/5A. E5421

PUBLIC APPOINTMENTS

CIVIL SERVICE COMMISSION

SENIOR SCIENTIFIC OFFICERS, SCIENTIFIC OFFICERS

The Civil Service Commissioners invite applications for pensionable appointments. Applications to be accepted up to 31st December, 1955, but early application is advised as an earlier closing date may be announced. Interview Boards will sit at frequent intervals. The Scientific Posts cover a wide range of scientific research and development in most of the major fields of fundamental and applied science. In biological subjects the number of vacancies is small; individual vacancies exist for candidates who have special knowledge of, or who are interested in, geobotany, foraminifera, and recent and pleistocene mammals.

Candidates must have obtained a University degree with First or Second Class Honours in an appropriate scientific subject (including engineering) or Mathematics, or an equivalent qualification, or possess high professional attainments. Candidates for Senior Scientific Officer Posts must, in addition, have had at least three years' post-graduate or other approved experience.

Candidates taking their Degrees in 1955 may apply before the result of their Degree examination is known.

Age limits: Senior Scientific Officers, between 26 and 31, but specially suitable candidates under 26 may be admitted. For Scientific Officers, between 21 and 28 during 1955 (up to 31 for permanent members of the Experimental Officer class). Salary (London): Senior Scientific Officers, (men) £1010–£1185; (women) £893–£1077. Scientific Officers, (men) £492–£885; (women) £492–£795. Women's salaries subject to improvement under equal pay scheme. Somewhat lower rates in the Provinces.

Further particulars from Civil Service Commission, Scientific Branch, 30, Old Burlington Street, London, W.1, quoting No. S.53/55 for Senior Scientific Officers and S.52/55 for Scientific Officers. E5418

CENTRAL ELECTRICITY AUTHORITY

CHIEF ENGINEER'S DEPARTMENT, HEADQUARTERS

SENIOR CIVIL ENGINEER

Applications are invited for the appointment of a SENIOR CIVIL ENGINEER in the Chief Engineer's Department at Headquarters in London.

The salary for the appointment, which is superannuable, will be within the range £2400–£2900 per annum.

Candidates should be Corporate Members of the Institution of Civil Engineers and have wide experience in the design and construction of large civil engineering works, preferably associated with thermal generating stations and hydro-electric projects.

Duties will include the critical examination of civil engineering problems involved in the construction of new and extension of existing generating stations.

Applications, stating age, qualifications, experience, present position and salary, to be forwarded to Sir E. Moffat, Director of Establishments, Winsley Street, W.1, to be received not later than 8th July, 1955. Quote AE/610. E5450

BRITISH RAILWAYS

SOUTHERN REGION

JUNIOR DRAUGHTSMEN

British Railways, Southern Region, urgently require JUNIOR DRAUGHTSMEN at their Carriage and Wagon Engineer's Headquarters, Eastleigh, Hants.

Candidates should have knowledge and experience of railway carriage design work in the drawing-office.

Annual holidays, travelling and superannuation facilities after qualification.

Apply to the Carriage and Wagon Engineer, Southern Railways, Southern Region, Eastleigh, Hants, stating age and minimum salary expected, giving details of training, experience and technical qualifications. E5390

LONDON TRANSPORT

ENGINEERING ASSISTANT

London Transport requires ENGINEERING ASSISTANT for design and construction of railway and engineering works; the post is temporary but with prospects of permanency. Applicants should be experienced in design and preparation of drawings, specifications and estimates for earthworks, structures, &c.; preferably be Members of a recognised professional Institution; capable of controlling design and supervising works executed by contract. Salary range £690–£840. Medical examination. Certain free travel facilities. Applications to Staff Officer (F/EV 539), London Transport, 55, Broadway, S.W.1. For acknowledgment enclose addressed envelope. E5396

MINISTRY OF WORKS

CIVIL ENGINEERING ASSISTANTS

Ministry of Works requires CIVIL ENGINEERING ASSISTANTS for sites in Hants, Notts and Kent, and for work in the Concrete Laboratory in London. Candidates must be of British birth and sufficient to check setting out with theodolite and level. Students who have passed Parts I and II of the A.M.I.C.E. examination will be considered, but not unless this previous site experience is essential. Commencing salary £462 to £695 per annum; provincial rates slightly less. Starting pay according to age and experience. Prospects of promotion.—State age, details of training and experience and location preferred, to Ministry of Works, W.G.10/C.6 (F), Atlantic House, John Islip Street, London, S.W.1. E5202

PUBLIC APPOINTMENTS

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY

ALDERMASTON, BERKS.

ENGINEER GRADE II

The United Kingdom Atomic Energy Authority, Aldermaston, Berks., requires an ENGINEER, Grade II, to be responsible for the efficient operation, maintenance, overhaul and replacement of mechanical engineering plant (particularly heating, ventilation and air extraction plant) and chemical plant (water purification and effluent treatment plant) installed in or associated with the safe operation of laboratories handling radioactive and other highly toxic materials. Applicants should have served a recognised engineering apprenticeship and should be either Corporate Members of one of the Institutions of Electrical or Mechanical Engineers or possess exempting qualifications. Previous experience of the operation of plant dealing with radioactive or toxic materials and of the associated hazards is desirable. They should be able to initiate and advise on the design of special equipment.

Salary: £1065–£1370 p.a. (male).

Superannuation: The successful applicant will be required to join the Authority's contributory scheme.

Housing: Housing accommodation will be available within a reasonable period for married officers who live outside the radius of the Establishment's transport facilities or alternatively the Authority may be able to assist successful applicants in the purchase of a house.

Requests for application forms by postcard to Senior Recruitment Officer, A.W.R.E., Aldermaston, Berks. Quote reference 675/WGE/25. E5471

COUNTY BOROUGH OF BRIGHTON

WATERWORKS DEPARTMENT

JUNIOR ASSISTANT ENGINEER GRADE A.P.T. IV

JUNIOR ASSISTANT ENGINEER, Grade A.P.T. IV (£675–£825).

General Waterworks experience required.

Must hold University Degree in Civil Engineering and/or Corporate Membership of either the Institution of Civil, Mechanical or Municipal Engineers.

Appointment superannuable, terminable by one month's notice on either side and subject to medical examination.

Application form from Waterworks Engineer—12, Bond Street, Brighton—to be returned to him suitably endorsed by 9th July, 1955.

W. O. DODD,
Town Clerk.

Town Hall,
Brighton, 1. E5458

BRITISH TRANSPORT COMMISSION

BRITISH TRANSPORT WATERWAYS

SENIOR ENGINEERING ASSISTANT (MECHANICAL AND ELECTRICAL)

British Transport Commission, British Transport Waterways, 22, Dorset Square, London, N.W.1, invite applications for the appointment of SENIOR ENGINEERING ASSISTANT (MECHANICAL AND ELECTRICAL), Divisional Engineer's Office, South Western Waterways Division, Gloucester—salary range £900–£1100.

Applicants should be Associate Members of the Institution of Electrical Engineers, with mechanical experience, or of the Institution of Mechanical Engineers with considerable up-to-date electrical experience.

The selected candidate will be required to join, if eligible, a contributory superannuation scheme of the Commission. Applications, stating age, experience and qualifications, should be sent to the Staff and Establishment Officer, at the above address, not later than 30th June, 1955. E5457

NATIONAL COAL BOARD

MINES MECHANISATION TRAINING CENTRE

ELECTRICAL INSTRUCTOR

National Coal Board invite applications for a superannuable appointment as ELECTRICAL INSTRUCTOR at the Mines Mechanisation Training Centre, West Bar, Sheffield. Candidates should have a thorough knowledge of the design, installation, repair and operation of all types of surface and underground electrical equipment. Teaching experience and a Higher National Certificate (Electrical) would be an advantage. Salary range £591 10s.–£691 10s.

Write, giving full particulars (in chronological order), of age, education, qualifications and experience (with dates), to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, marking envelope SS/18. Original testimonials should not be forwarded. Closing date 5th July, 1955. E5483

LONDON COUNTY COUNCIL

CIVIL ENGINEERING ASSISTANTS

Experienced CIVIL ENGINEERING ASSISTANTS required for design of road networks in clearance areas, design of new roads and road improvements; supervision of construction contracts. Salaries according to qualifications and experience. Apply personally or by letter to Chief Engineer (55/36), London County Council, County Hall, S.E.1. (877) E5252

PUBLIC APPOINTMENTS

NATIONAL COAL BOARD

CIVIL ENGINEERING SECTION OF PRODUCTION ENGINEERING BRANCH

SPECIALIST ENGINEERS

National Coal Board invite applications for superannuable appointments as SPECIALIST ENGINEERS in the Civil Engineering Section of Production Engineering Branch at London Headquarters. Candidates should have a Degree in Civil Engineering or be Graduate Members of the Institution of Civil Engineers or of the Institution of Structural Engineers with adequate civil engineering experience. In addition, they should have had at least two years' experience in an engineering design office on works involving structural steelwork or concrete construction. Some site experience would be an advantage. Salary, depending upon qualifications and experience, will be within the range £500–£1000 per annum, but not less than £650 at the age of 25.

Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates), to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, marking envelope SS/17. Original testimonials should not be forwarded. Closing date 18th July, 1955. E5482

HER MAJESTY'S OVERSEA CIVIL SERVICE

NIGERIA

SENIOR EXECUTIVE ENGINEER (ROADS)

A vacancy exists for a SENIOR EXECUTIVE ENGINEER (ROADS) in the Public Works Department in the Western Region of Nigeria, to administer and exercise general supervision over a large-scale programme of road development and improvement.

Appointment on contract/gratuity terms with gross emoluments of £2150 p.a. plus substantial gratuity on satisfactory completion of contract, £60 outfit allowance, free first-class passages for officer and wife and assistance for children. Generous home leave.

Candidates should be Corporate Members of the Institution of Civil Engineers and have had not less than ten years' experience in road construction and bituminous surfacing works, supervision of major contracts for road works and control of staff.

Full details on application to the Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, giving brief details of age, qualifications and experience. Quote reference BCD 112/410/013/D4 Nigeria. E5432

THE PARSONS AND MARINE ENGINEERING TURBINE RESEARCH AND DEVELOPMENT ASSOCIATION

RESEARCH ENGINEERS

The Parsons and Marine Engineering Turbine Research and Development Association has two vacancies for RESEARCH ENGINEERS with Engineering Degree or equivalent, for interesting and varied work on full-scale trials of prototype steam machinery installations. Duties include the planning of trials, analysis of results and the writing of reports. Experience of steam plant operation is desirable but not essential. Salaries compare favourably with the Scientific Civil Service and there are superannuation and other benefits.

Applications in writing, stating age and experience, should be addressed to the Research Director, Pametrada Research Station, Wallsend, Northumberland. E5477

USK RIVER BOARD

ASSISTANT ENGINEER

Applications are invited for the appointment of ASSISTANT ENGINEER, on Grade II (£560 by £20 to £640). Applicants should be competent Surveyors and Levellers and should preferably have had experience of the design and/or construction of land drainage works. The position will be subject to the provisions of the Local Government Superannuation Act, 1953. The person appointed will be required to pass a medical examination.

Applications, for which no standard form is required, should be addressed to the undersigned, to be received not later than 8th July, 1955. Applicants should state their age, technical training, qualifications and previous experience, and should give the names of two referees. The appointment will be terminable on one months' notice on either side.

G. McLEOD, M.I.C.E.,
Engineer to the Board.

The Croft,
Goldcroft Common,
Caerleon, Mon.
15th June, 1955 E5454

MINISTRY OF WORKS

ENGINEERING DRAUGHTSMEN

Ministry of Works require ENGINEERING DRAUGHTSMEN in London and various provincial offices with O.N.C. or equivalent standard, and at least three years' experience, including one in a drawing-office in general mechanical engineering, electric power and lighting installation work or heating and ventilating installation work. Candidates must have British nationality. London salary £462 to £695 per annum; rates elsewhere slightly less. Starting pay according to age and experience; prospects of promotion and permanency.—State age and full details of training and experience to Chief Engineer, Ministry of Works, W.G.10/15(E), Abell House, John Islip Street, London, S.W.1. E9676

PUBLIC APPOINTMENTS

ATOMIC ENERGY RESEARCH ESTABLISHMENT

HARWELL

DEVELOPMENT ENGINEERS

Atomic Energy Research Establishment, Harwell, has vacancies for DEVELOPMENT ENGINEERS in its Instrument Department, for interesting work on instruments for Atomic Energy uses, mainly concerned with industrial process and electronic application.

Qualifications: Corporate Membership of the Institution of Mechanical or Electrical Engineers, or an Honours Degree in Engineering, or exempting qualifications. Applicants should preferably have served a recognised engineering apprenticeship. Previous design or development experience in instruments process control is desirable, although applicants with experience of development work in other instrument engineering fields will be considered.

Salary: The posts are graded Engineer III and salary scale is £695 (at age 25)–£1065 p.a. Successful candidates will be required to join the Authority's contributory superannuation scheme.

Housing: A house will be available within a reasonable period of time for the selected officer if he is married and lives outside the radius of the Establishment's transport facilities.

Requests for application form should be sent on a postcard to Establishments Officer, U.K. Atomic Energy Authority, A.E.R.E., Harwell, Didcot, Berks, quoting 2/103/277. E5528

WEST MIDLANDS GAS BOARD

BIRMINGHAM AND DISTRICT DIVISION

ASSISTANT CONSTRUCTIONAL ENGINEER

Applications are invited for the above position on the Divisional Engineer's Staff at Saltley Works, Birmingham.

Candidates must have had good drawing-office training and experience, including the layout of all types of gas works plant, the preparation of specifications and estimates, and the general supervision of contracts on site. They must also have had some experience of building contracts, including reinforced concrete work.

Experience with gas works contractors will be an advantage.

The salary will be within the salary range £950–£1100.

The post is pensionable and the successful candidate may be required to pass a medical examination.

Applications, stating age, qualifications and particulars of training and experience, together with the names of two referees, should be addressed to the Industrial Relations Officer, West Midlands Gas Board, 6, Augustus Road, Edgbaston, Birmingham, 15, to reach him within fifteen days of the appearance of this advertisement.

J. C. INGRAM,
E5518 Secretary to the Board.

HER MAJESTY'S OVERSEA CIVIL SERVICE

PUBLIC WORKS DEPARTMENT, FIJI

ASSISTANT ENGINEER (MECHANICAL)

Duties include boiler and machinery inspections, including electrical installations and supervision of workshop construction and repairs.

Appointment is pensionable on probation for three years in the salary scale £F750–£F1600 (£F111 =£ sterling 100). Free passages provided up to a maximum of four adult fares on first appointment. Leave on full salary at the rate of 4–5 days for each month of resident service after a tour of four years.

Candidates, preferably under 40 years of age, should be A.M.I.Mech.E. and have electrical experience, or A.M.I.Mech.E. with a M.O.T. First Class Certificate, or hold a M.O.T. First Class Certificate and have electrical experience. A sound practical knowledge of boiler construction and machine shop maintenance, and experience in the maintenance of all types of power equipment is required.

Apply in writing to the Director of Recruitment, Colonial Office, London, S.W.1, giving briefly age, qualifications and experience. Mention the reference No. BCD 112/49/07/D4. E5504

CITY OF NOTTINGHAM

APPOINTMENTS

(a) ASSISTANT STRUCTURAL ENGINEER (A.P.T. VI, £930–£1000 p.a.).

(b) ASSISTANT ENGINEERS (A.P.T. V, £750–£900 p.a.).

(c) JUNIOR HEATING ENGINEER (A.P.T. I to III, £500–£725 p.a.).

Applications are invited for the above positions in the City Engineer's Department, Nottingham. Particulars of the posts are:

(a) The person appointed will be in charge of important bridge design work and should be experienced in design in steel R.C. work and prestressed concrete, commencing salary in Grade A.P.T. VI is £930 p.a.

(b) Candidates should be experienced in the design of one of the following classes of work:—Sewage disposal works, main drainage, bridges, structural frames, highways.

(c) Candidates should be capable of working on heating schemes under supervision.

Commencing salaries for posts (b) and (c) will depend on experience.

Housing accommodation is available.

Applications on forms to be obtained from R. M. Finch, O.B.E., M.I.C.E., City Engineer, Guildhall Nottingham, are to be returned to him by 30th June, 1955. E5292

For continuation of Small Advts., page 4

PUBLIC APPOINTMENTS

LONDON COUNTY COUNCIL

DEPARTMENT OF THE CHIEF ENGINEER AND COUNTY SURVEYOR

APPOINTMENTS

Required :
(a) ASSISTANT DIVISIONAL ENGINEER, £1350–£50–£1550–£75–£1700.
(b) ASSISTANT SENIOR ENGINEER, £1275–£63–15s.–£1530.

Candidates should be Corporate Members of the Institution of Civil Engineers or hold other approved qualifications. The duties of appointment (a) will include deputising for the Divisional Engineer as required.

For both positions experience in the design and execution of major street improvements, the engineering aspects of town planning, Parliamentary Bills, attendance at Committees and negotiations with Government Departments and public authorities is desirable.

The positions are permanent and pensionable.

Applications must be submitted by 18th July, 1955, on the prescribed form, obtainable, together with full particulars, from the Clerk of the Council (CL/F2), the County Hall, S.E.1. (986) E5445

CITY OF MANCHESTER

DAVYHULME SEWAGE WORKS EXTENSION SCHEME

SENIOR ASSISTANT ENGINEER

Applications are invited for the appointment of a SENIOR ASSISTANT ENGINEER in Grade A.P.T. V (£750/£900) in connection with the design and subsequent supervision of the construction of major extensions at the Davyhulme Sewage Works, estimated to cost over £5,000,000.

It is anticipated that subject to satisfactory service the duration of appointment will be at least ten years.

Applicants should preferably be Corporate Members of the Institution of Civil Engineers, and it is desirable that they should have had considerable and wide experience on similar works of sewerage and sewage disposal.

Applications, stating age, education, qualifications and experience, together with the names of three persons to whom reference can be made, should be delivered to the City Surveyor, Town Hall, Manchester, not later than Friday, the 1st July, 1955. E5291

BRITISH OVERSEAS AIRWAYS CORPORATION

CIVIL ENGINEER'S SECTION

ELECTRICAL AND MECHANICAL ASSISTANT

British Overseas Airways Corporation require an ELECTRICAL AND MECHANICAL ASSISTANT in the Civil Engineer's Section at London Airport. Applicants should preferably be Associate Members of the Institution of Electrical Engineers or other recognised professional bodies, and have practical experience in preparing schemes and estimates for electrical and mechanical services in industrial buildings. The duties may involve short tours abroad, with appropriate allowances. The salary will be within the range £742 10s. to £867 10s. per annum, according to qualifications and experience. Applications in writing to Mr. R. E. Richardson, Staff Manager, B.O.A.C. Headquarters Building, London Airport, Hounslow, Middlesex, stating age and details of qualifications and experience. E5525

ALL SAINTS' HOSPITAL, BIRMINGHAM, 18

ASSISTANT ENGINEER

ASSISTANT ENGINEER required. Salary £500 by £15 to £575.

For active participation and supervision in the maintenance and operation of the mechanical and electrical engineering services of the hospital under the direction of the Group Engineer. Candidates must have served an apprenticeship in mechanical engineering ; possess, or be studying for, the Ordinary National Certificate (Mech. Eng.) ; have extensive practical experience of engineering maintenance and reside near the hospital.

Conditions of appointment as Whitley Council agreements. Applications, stating age, experience and qualifications, and the names of three referees to be sent to the Secretary within 14 days after the appearance of this advertisement. E5531

COVENTRY CORPORATION WATER UNDERTAKING

GRADUATE TRAINEE

Coventry Corporation Water Undertaking invite applications from University Graduates for post of GRADUATE TRAINEE, Grade A.P.T. 2–3, £560 to £725 p.a.

Apply for details.

WATER ENGINEER.
Council House, Coventry. E5516

LONDON COUNTY COUNCIL

ENGINEERING DRAUGHTSMEN AND WOMEN

ENGINEERING DRAUGHTSMEN and WOMEN required for civil, mechanical engineering work. All positions pensionable. Salaries according to qualifications and experience.—Apply personally (Room 457) or by letter to Chief Engineer (55/38), London County Council, County Hall, S.E.1. (891.) E750

SOUTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD

ASSISTANT ENGINEER (MECHANICAL)

Applications are invited for the post of ASSISTANT ENGINEER (MECHANICAL). Commencing salary within the scale £625 by £25 (7) by £30 (2) to £890 p.a., plus London weighting allowance of £30 p.a. (age 26 and over), rising to £40 p.a. at £801 p.a.

Applicants should have served a recognised engineering apprenticeship and must be Graduate Members of the Institution of Mechanical Engineers and have passed Sections A and B of the Associate Membership examination, or hold exempting qualifications. Corporate Membership of the Institution of Heating and Ventilating Engineers will qualify.

Sound experience of design of mechanical service of large buildings required. Drawing-office and estimating experience an advantage.

Applications, stating age, experience, qualifications, present appointment, and salary, together with the names and addresses of three referees, should be sent to the Secretary (S.2), 11a, Portland Place, London, W.1 (marking the envelope "Engineering Staff") not later than 13th July. E5517

THE PARSONS AND MARINE ENGINEERING TURBINE RESEARCH AND DEVELOPMENT ASSOCIATION

APPLIED PHYSICS SECTION

APPOINTMENT

The Parsons and Marine Engineering Turbine Research and Development Association have a vacancy in the Applied Physics Section which deals with a wide variety of problems, mainly concerned with noise and vibration. Applicants should have a Degree in Physics or Mathematics, but previous experience is not essential. Salaries compare favourably with the Scientific Civil Service and there are superannuation and other benefits. Apply in writing to the Research Director, Pametrada Research Station, Wallsend, Northumberland. E5451

CITY OF NOTTINGHAM

CITY ENGINEER'S DEPARTMENT

GRADUATE ASSISTANT ENGINEER

(£560–£775 p.a.)

Applications are invited for the above position in the City Engineer's Department. Applicants should have (or be sitting for this summer) a University Degree or a Diploma giving exemption from the Institution of Civil Engineers examinations. The person appointed will be registered under the Training of Municipal Engineers Scheme and given experience of all branches of municipal engineering work as carried on in the City Engineer's Department.

Commencing salary is £560 per annum, rising after two years' training to £650 and then by £25 per annum to £775.

Applications, on forms to be obtained from R. M. Finch, O.B.E., M.I.C.E., City Engineer and Surveyor, Guildhall, Nottingham, are to be returned not later than Friday, 15th July, 1955. E5430

EUROPEAN COUNCIL FOR NUCLEAR RESEARCH, GENEVA

RESEARCH PHYSICISTS, ELECTRICAL, ELECTRONIC AND MECHANICAL ENGINEERS

European Council for Nuclear Research, Geneva has a number of vacancies for RESEARCH PHYSICISTS, ELECTRICAL, ELECTRONIC and MECHANICAL ENGINEERS to assist in the design and construction of high-energy accelerating machines for nuclear research. The posts, in varying grades, carry salaries ranging from 10,200 to 20,100 Swiss francs tax free per annum.

First-class qualifications and experience essential. —For further information and application forms write to the Secretary, Ministry of Labour and National Service, Almack House, 26, King Street, London, S.W.1, quoting A12/179/CERN. E5428

MINISTRY OF WORKS

STRUCTURAL ENGINEERING DRAUGHTSMEN

Ministry of Works require STRUCTURAL ENGINEERING DRAUGHTSMEN in London, Edinburgh and various provincial offices, with experience in the design and/or detailing of reinforced concrete or structural steelwork. London salary £442 to £695 per annum ; rates elsewhere slightly less. Starting pay according to age and experience ; prospects of promotion and permanency.—State age and full details of training and experience to Ministry of Works, W.G.10/S8(F), Abell House, John Islip Street, London, S.W.1. E9677

BRITISH TRANSPORT COMMISSION

BRITISH RAILWAYS—WESTERN REGION

CIVIL ENGINEERING ASSISTANTS

CIVIL ENGINEERING ASSISTANTS required with sound technical training and experience in general civil engineering and building design and construction.

Salary range : £660–£900 p.a., according to qualifications and experience.

Apply to Chief Civil Engineer, Paddington Station, London, W.2. E5395

MINISTRY OF SUPPLY

MALVERN, WORCS

REFRIGERATION AND AIR CONDITIONING TECHNICIAN

Ministry of Supply requires REFRIGERATION and AIR CONDITIONING TECHNICIAN at Malvern, Worcs, to supervise operation of large stratosphere chamber to simulate extreme climatic and high-altitude conditions, and centrifuge test house for sustained accelerations ; also smaller similar plants. Occasional shift work. British of British parents. Recognised engineering apprenticeship. Experienced production of temperatures to minus 75 C., preferably using arcton, ammonia and menthanol. Knowledge light electrical control and instrument equipment advantage. H.N.C. or equivalent desirable. Salary, within £772–£945 p.a. Not established, but opportunities to compete for establishment may arise.—Application forms from M.I.L.N.S., Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C587/54A. E5417

LONDON COUNTY COUNCIL

ENGINEERS AND ENGINEERING ASSISTANTS

Required, CIVIL ENGINEERS and CIVIL ENGINEERING ASSISTANTS :

(i) For design of large civil engineering works in connection with main drainage and sewage purification.

(ii) For road design and construction.

(iii) For design and detailing of engineering structures in concrete and steel.

STRUCTURAL ENGINEERS, for detailing engineering structures in concrete and steel.

All positions pensionable with opportunities for the future. Salaries in accordance with qualifications and experience.—Apply personally (Room 457) or by letter to Chief Engineer (55/37), London County Council, County Hall, S.E.1 (890.) E749

NATIONAL COAL BOARD

NORTHERN (N & C) DIVISION

GROUP ENGINEER (MECHANICAL AND ELECTRICAL)

Applications are invited for a post of GROUP ENGINEER (Mechanical and Electrical), No. 3 Area, Ashington, Northumberland. Applicants must have thoroughly sound experience of colliery engineering. Experience of large-scale reconstruction schemes would be an advantage. Salary range £900–£1600 p.a., commencing salary according to age, experience, qualifications, &c.—Applications, giving full personal details, to be submitted to the undermentioned by 16th July, 1955, quoting the reference V.63, Area Administrative Officer, National Coal Board, Northern (N & C) Division, No. 3 Area, Mining Offices, Ashington, Northumberland. E5475

THE BRITISH COAL UTILISATION RESEARCH ASSOCIATION

RESEARCH OFFICER

RESEARCH OFFICER required by the British Coal Utilisation Research Association for research relating to the gasification of coal. A Degree in Physics, Chemical or Mechanical Engineering is desirable. Initial salary in the range £590–£740. Superannuation and grading scheme.—Apply in writing to Assistant Secretary, Ref. B.29, B.C.U.R.A. Randalls Road, Leatherhead, Surrey. E5484

SOUTHAMPTON CORPORATION WATERWORKS

CIVIL ENGINEERING ASSISTANT

Southampton Corporation Waterworks require CIVIL ENGINEERING ASSISTANT, age not exceeding 35. Must have passed Parts A and B, Institution of Civil Engineers, or exempting examination. Experience in waterworks advantageous. Salary A.P.T. "Special Scale" (£650–£775). Conditions of appointment form, and applications to, Joseph Hawksley, M.I.C.E., Waterworks Engineer, Civic Centre, Southampton, by Wednesday, 13th July, 1955. E5513

TENDERS

KARACHI PORT TRUST

PERMANENT WAY MATERIALS

TENDERS are invited for the MANUFACTURE and SUPPLY C.I.F. Karachi, of approximately 3796 tons of PERMANENT WAY MATERIALS, comprising Rails, Fishplates, Fishbolts, Bearing Plates, Dogspikes and Coachscrews.

The relative drawings and P.R. Standard Specifications, together with schedule of quantities, are obtainable from the Trust's Consulting Engineers, Messrs. Rendel, Palmer and Tritton, 125, Victoria Street, Westminster, London, S.W.1, upon a non-refundable payment of Rs.25/-/- (£2 13s. 10d.) per set.

Tenders, in sealed envelopes, endorsed on the outside "Tender for Supply of Permanent Way Materials," addressed to The Chief Engineer, Karachi Port Trust, Karachi, Pakistan, should reach the Chief Engineer not later than 12 noon on the 4th August, 1955, to be opened in the presence of those tenderers who wish to be present, and should remain open for acceptance up to 4th February, 1956.

The Chief Engineer does not bind himself to accept the lowest or any quotation and reserves the right to reject any quotation without assigning any reasons. E5380 (Signed) CHIEF ENGINEER.

TENDERS

THE COMMISSIONERS FOR THE PORT OF CALCUTTA

RIVER HOOGHLY TRAINING WORKS

TENDERS are invited from suitable Contractors for RIVER TRAINING WORKS at Fulta Point comprising the removal of a protrusion on the left bank of the River Hooghly by means of dredging and/or land excavation, and utilisation of the material for reclamation on the opposite bank, together with necessary protection work, &c. ; also dredging in the river bed at specified places. The approximate total quantity of material to be removed is 6·5 million cubic yards.

Drawings, conditions of contract and specifications may be obtained from either the Chief Engineer, Commissioners for the Port of Calcutta, 15, Strand Road, Calcutta, India, upon payment of a Treasury fee of Rs.20 or from the Commissioners' Consulting Engineers and London Agents, Messrs. Rendel, Palmer and Tritton, 125, Victoria Street, Westminster, London, S.W.1, upon payment of a fee of £1 10s. Such Tender fee will not be refundable.

Applications from Agents or other intermediaries will not be considered.

Tenderers are required, before submitting their Tenders, to deposit as earnest money Rs.25,000 or £2000 sterling, and a receipt for this amount must accompany the Tender. Such earnest money is returnable to unsuccessful tenderers on application.

Tenders shall be submitted in triplicate ; two copies to Messrs. Rendel, Palmer and Tritton, at 125, Victoria Street, Westminster, London, S.W.1, to reach them not later than 10.30 hours G.M.T. on 22nd August, 1955, and one copy to the Chief Engineer, Commissioners for the Port of Calcutta, 15, Strand Road, Calcutta, India, by 16.00 hours I.S.T. on the same date.

The Commissioners do not bind themselves to accept the lowest or any Tender, and reserve the right to reject a Tender without assigning reasons.

(Sgd.) T. M. MALKANI,
Chief Engineer.
Calcutta Port Commissioners. E5

EDUCATIONAL

COUNTY BOROUGH OF BOURNEMOUTH

MUNICIPAL COLLEGE OF TECHNOLOGY AND COMMERCE

Principal : M. L. YATES, M.A. (Com.), M. Tech., Ph.D., M.I.Mech.E.

FULL-TIME AND PART-TIME COURSES

FULL-TIME and PART-TIME COURSES provided in preparation for the following :—

B.Sc. General (Chemistry, Physics, Biology, Mathematics), University of London External Degrees.

B.Sc. Engineering (Electrical, Mechanical), University of London External Degrees.

B.Sc. Economics, University of London External Degrees.

Accountancy.

Provision is made for students' social and athletic interests.

Applications for admission should be addressed to the Principal, from whom any further particulars required may be obtained. Telephone Bournemouth 1520–1. E5478

A.M.I.MECH.E., B.SC., City and Guilds, etc. Guaranteed Postal Courses for all Exams, and Technical Divisions from Elementary to Degree standard. Approximately 95 per cent. successes. 144-page prospectus free on request.—B.I.E.T. (Dept. 22), Wright's Lane, London, W.8. E7

FREE ! Brochure giving details of Courses in Mechanical and Production Engineering, Draughtsmanship, &c., for the A.M.I.Mech.E., A.M.I.P.E., City and Guilds and other Professional Examinations. E.M.I. Institutes, Dept. E.30, London, W.4. (Associated with H.M.V.) E7

SITUATIONS VACANT

NOTIFICATION OF VACANCIES ORDER, 1952

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18–64 inclusive or a woman aged 18–59 inclusive, unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A BRITISH COMPANY, representing extensive engineering interests, requires a young Structural Engineer for a progressive position in South India. Sound apprenticeship and practical experience essential. Recognised qualification and aptitude for commercial work an advantage. Candidates should be single and not over 28. Remuneration in line with qualifications and experience. There is participation in a bonus fund, and frequent paid home and local leaves are given. Pension scheme and provident fund.—BOX No. E5403, "The Engineer."

A FAMOUS AERO ENGINE firm in Midlands has vacancy for Engineer with Degree or H.N.C. to carry out special investigations into strength of gas turbine engine components. Applicants with Degree in Physics or Mathematics also eligible. Previous experience not essential. A vacancy also exists for work on the installation of engines in aircraft, requiring similar qualifications. Initial salary, £600/£860, dependent on age and qualifications. Superannuation scheme operating. Excellent prospects. Apply, quoting reference SF/S.—BOX No. E5404, "The Engineer."

SITUATIONS VACANT

A CAREER FOR SENIOR PIPING DESIGNERS

An established international Company of consulting and contracting engineers to the chemical and oil industries invites applications from

SENIOR PIPING DESIGNERS
who seek permanent posts

Applicants should have H.N.C. (Mechanical) or recognised engineering experience, plus good knowledge of pipework arrangement in oil refineries, chemical or power plant.

These posts carry progressive salaries, pension rights and generous sickness benefits.

Temporary vacancies also exist for DRAUGHTSMEN & DRAUGHTSWOMEN for piping work.

Apply in writing detailing age, qualifications and experience to the
Personnel Manager,
Dept. 29/G,
Kellogg International Corporation,
7-8, Chandos Street,
London, W.1.
E5472 A

HEAVY ENGINEERING COMPANY in the West of England offers excellent opportunities to engineers with experience in heavy plant design, hydraulics and hydraulic servo mechanisms. Assistance with housing if necessary. Salary and bonus commensurate with ability. Excellent conditions, pension scheme, interviews arranged at weekends. Details of experience, qualifications and age to Personnel Director.—BOX No. E5346, "The Engineer." A

JUNIOR SALES DIRECTOR required for leading Structural Steel Contractors, London area, must have design background and with active client connections. State age, experience and salary required.—BOX No. E5456, "The Engineer." A

LARGE FIRM of reinforced concrete engineers in Rhodesia and the Union of South Africa, has vacancies for Reinforced Concrete Designers and Fitters with experience.—Apply in writing, with full details of qualifications and experience, age and salary required, to BOX "R4/4/55," c/o 95, Bishopsgate, E.C.2. E731 A

LARGE INDUSTRIAL ORGANISATION wishes to inteview young Pakistani Mechanical Engineers on behalf of its Pakistan Associated Company. Candidates must possess a good Degree in Mechanical Engineering and preferably should have some industrial experience. Reply, stating details of age, qualifications and experience, to—BOX No. E5506, "The Engineer." A

MAJOR OIL COMPANY invites applications for the following positions :
DRAUGHTSMEN.—Applicants should possess at least an O.N.C. and have had experience of piping layout or civil or mechanical engineering.
ASSISTANT ENGINEERS.—Applicants should possess a Mechanical Engineering degree or equivalent qualifications. Experience in the petroleum or allied industries will be advantageous, but applications from recently qualified graduates will be considered. Housing accommodation is available and the company operates a pension and life assurance scheme, sickness benefit plan and sports and social club. Applications with details of qualifications and experience should be sent. —BOX No. E5459 "The Engineer." A

A NUMBER OF FULLY-QUALIFIED MECHANICAL HANDLING DRAUGHTSMEN are required in a West End drawing-office. Experience in bulk and package handling. Ideal working conditions.—BOX No. E5219, "The Engineer." A

PROGRESSIVE ORGANISATION has a vacancy for a Qualified Engineer. The successful applicant must have a good potential and be capable of undertaking responsibility within a reasonable time. The vacancy is an attractive one with good prospects and a good commencing salary. Please send full details of experience, age and qualifications, to—BOX No. E5508, "The Engineer." A

TECHNICAL MANAGER is required for an industrial company in the London area engaged in the manufacture of aluminium foil and collapsible tubes. Basic engineering qualifications essential. Age 35/45. Experience in similar work desirable. Please reply, giving full particulars.—BOX No. E5494, "The Engineer." A

TOP GRADE EXECUTIVE is required by well known general engineering company located in the North of England, for an important executive position on the manufacturing side of the organisation. Applicants must essentially possess a sound engineering background, a good knowledge of machine tools, experience in works management, drive and enthusiasm, and preferably a degree in engineering. The position offers excellent prospects and a generous superannuation scheme is in operation. Please give full details of age, education, experience and salary required etc.—BOX No. E5481, "The Engineer." A

WELL-KNOWN ORGANISATION has vacancies for two Technical Assistants in the production and technical department. Applicants must hold a good University Degree in Mechanical Engineering or be aged 24-30, having acquired a sound technical background in the engineering industry. An attractive salary is offered and in addition there are very good prospects for further promotion. Reply, giving full details of age, qualifications and experience to—BOX No. E5507, "The Engineer." A

ADREMA, LTD., London (Acton), have a vacancy for the post of Head of Research and Development with an initial salary of not less than £2000 per annum. Applicants should be qualified mechanical engineers, with a good understanding of the application of electronics, and must have previous experience in the principles and design of office machines, such as dressing machines, typewriters, punch card or accounting machines, printing and duplicating or similar equipment.—Applications, with curriculum, to the Managing Director, Adrema, Ltd., 2–10, Oxford Way, London W.3. E5381 A

A.E.C. LIMITED, require Detail Draughtsmen to fill vacancies in recently completed extension to engineering drawing office. Experience of the motor industry would be an advantage. Modern office and equipment, excellent opportunities for progress, good salary offered, five-day week, pension scheme and canteen facilities. —Applications, in writing, giving age, experience and salary required, to Staff Records Office, Dept. B, Windmill Lane, Southall, Middlesex. E9912 A

AERODYNAMICISTS, PHYSICISTS, MATHEMATICIANS AND ENGINEERS.—A rapidly expanding aircraft instrument firm engaged on the design and development of autopilots for aircraft and helicopters has vacancies for the following :
(a) Stability and control analysis.
(b) Flight simulator assessment of aircraft stability.
(c) Aircraft flight trials of equipment.
Previous experience in the aerodynamics or flight test department of aircraft or guided weapons industry desirable but not essential.
(d) Testing and development of electro-hydraulic servo-mechanisms.
Previous experience with hydraulics not essential. Good electrical knowledge is necessary. Duties will include testing equipment at hydraulic firms.
Please apply, giving full details of career and salary required (which will be treated in strict confidence), to Personnel Officer, Louis Newmark, Ltd., Prefect Works, Purley Way, Croydon, Surrey. E9926 A

AIRCRAFT ELECTRICAL DRAUGHTSMEN required by large company for important work in London. Good salary, in addition living allowance paid to applicants coming from outside the district. Pension scheme, excellent conditions. Apply giving particulars of experience and qualifications. —BOX No. E5480, "The Engineer." A

AN APPOINTMENT with a commencing salary up to £2,000 per annum is about to be made to its permanent staff by an Industrial Company with interests at Home and Abroad. The duties are administrative and apply to the effective organisation and direction of production. Knowledge and experience of modern production methods is essential therefore, and a capacity to inspire confidence at all levels. The appointment is pensionable and applicants, aged 30 to 35 years, are expected to have a University Degree and experience of executive responsibility. To applicants engaged in works or production management this appointment has outstanding prospects. Full details should be sent.—BOX No. E5487, "The Engineer." A

AN EXCELLENT OPPORTUNITY exists for a Mechanical Engineer, A.M.I.Mech.E., or equivalent qualification, aged about 30, to join a well-known progressive firm of manufacturers in N. Staffs for training as Methods Engineer. Some experience in non-engineering production processes an advantage, but not essential, providing the applicant is adaptable and has the drive to get things done. A generous salary and, if necessary, assistance with housing is offered. Replies should state, in confidence, age, qualifications, experience and present salary.—BOX No. E5392, "The Engineer." A

AN EXCELLENT OPPORTUNITY exists with the British Oxygen Company, Limited, for a University Graduate in Engineering. Successful applicants will be required to undergo a period of approximately six months' training and will eventually be appointed to the Sales Organisation of the Company. No previous experience is necessary and applicants should be within the age group 22-26. Please reply to—Personnel Manager, The British Oxygen Company, Limited, Bridgewater House, Cleveland Row, St. James's, London, S.W.1. E5510 A

AN INDUSTRIAL COMPANY, outstanding in its own field, has a vacancy in its production department for a young man with drive and willingness to take progressive responsibility. First-rate prospects are offered to the successful applicant, who should have a Public School education, a Degree or A.M.I.Mech.E. standard of technical qualification and a good apprenticeship. Some executive experience of modern production methods is essential. The appointment is pensionable and carries a salary up to £2000 per annum. Applicants, aged about 30, are invited to send full particulars of their qualifications, &c.—BOX No. E5405, "The Engineer." A

AN INDUSTRIAL ORGANISATION requires two Science Graduates. Successful applicants will be trained in both Technical and Non-Technical Departments for six months, followed by a period of specialised training in a particular field. Future prospects in an interesting and expanding industry are extremely bright. Age range 20–27. Please reply, stating full details of age and qualifications to —BOX No. E5505, "The Engineer." A

AN OPPORTUNITY EXISTS with the British Oxygen Company for a young Engineer. Applicants should be aged 22–27 and hold a good Degree in Mechanical Engineering. Applicants should preferably have 1–2 years' industrial experience. This post offers excellent prospects. Reply, giving full details of qualifications and experience to—Personnel Manager, The British Oxygen Company, Limited, Bridgewater House, Cleveland Row, St. James's, London, S.W.1. E5514 A

APPLICATIONS ARE INVITED from Draughtsmen-Designers experienced in electro-mechanical equipment, mainly for aircraft. Excellent working conditions in pleasant surroundings in South Wales, 24 miles from Cardiff and Coast ; alternatively, in Nottingham or Reading. Apply, giving full particulars, to—Chief Engineer, Teddington Aircraft Controls, Ltd., Cefn Coed, Breconshire. E2342 A

ASSISTANT DESIGN ENGINEERS required by Richard Costain, Limited, for their Head Office. The duties will include the design of temporary site works, shuttering and permanent structures in reinforced concrete and steelwork. Site experience would be an advantage but not essential. Salary according to experience.—Apply The Chief Personnel Officer, 111, Westminster Bridge Road, London, S.E.1. E5448 A

APPLICATIONS ARE INVITED by The Associated Cement Companies, Ltd., a large industrial concern owning and operating Cement factories in Pakistan, for the post of a Works Chief Engineer.
Qualifications : (1) University Degree in Mechanical or Electrical Engineering. (2) 5 to 10 years' practical experience in engineering concerns of which at least three years should be in a responsible position. Cement Works experience preferred.
Starting Salary : Pak. Rs. 1200/- per month (equivalent to £129 approximately at the present exchange rate) plus a monthly Overseas Allowance of Pak. Rs. 300/-.
Main Terms : (1) Three years agreement subject to three months' notice, renewal at Company's option for a like period. (2) When joining duty, free ordinary first-class sea passage for self, wife and dependent children below 15 years age, plus similar free sea passage while proceeding on leave after three years service. (3) In addition to salary and overseas allowance, other benefits which include rent-free furnished house, dearness allowance, annual bonus, depending on company's profits, provident fund, etc., according to Company's rules.
Apply in duplicate stating nationality, age, marital status, qualifications, details of experience supported by copies of certificates and testimonials and latest photograph to Box No. JN/92, c/o 95, Bishopsgate, London, E.C.2. E5473 A

APPLICATIONS ARE INVITED for the position of Technical Representative by an important firm of heavy engineers and iron founders. The company is seeking a man of 30-40 with a good engineering background who could represent them in a wide range of products from their heavy foundries and steel fabrication shops. Experience of iron and steel works equipment, heavy duty rolling stock and/or pressure vessels desirable. The position is superannuated, carries a good salary and bonus and a car is provided. Applications should give fullest particulars, including age, education, previous experience and present salary.—BOX No. E5490, "The Engineer." A

APPLICATIONS ARE INVITED for the post of Chief Designer with a firm engaged in the construction of bulk handling mechanical and chemical construction contracts. Applicants should be essentially mechanical engineers with extensive design experience, first class in drawing office organisation and possess energy and initiative. Appointment is permanent and pensionable. Write stating age, qualifications and salary required to—Box No. 8848, c/o Charles Barker and Sons, Ltd., 31, Budge Row, London, E.C.4. E5503 A

ASSISTANT CIVIL ENGINEERS wanted for consulting engineers' office in London. Applicants should be Corporate Members of the Institution of Civil Engineers or be exempt from Sections I and II of the A.M.I.C.E. Examination. They should have good drawing-office experience, preferably in connection with docks, harbours and railways. Some site experience will be an advantage. Age 25 to 40. Five-day week, pension scheme, recreation and luncheon clubs.—Apply by letter, with full particulars of age, qualifications and experience, to Rendel, Palmer and Tritton, 125, Victoria Street, S.W.1. E5379 A

ASSISTANT ENGINEER with sound technical knowledge of air filtration problems and previous commercial experience for well-known firm in London area. Permanent position with salary according to ability. Five-day week, pension scheme. Holiday this year.—BOX No. E5308, "The Engineer." A

IMPERIAL CHEMICAL INDUSTRIES LTD.
WILTON WORKS.

ASSISTANT TECHNICAL OFFICER-DRAUGHTSMEN.

MECHANICAL, ELECTRICAL, STRUCTURAL, CIVIL, INSTRUMENTATION.

There are several vacancies in each category. Applicants should have the appropriate National Certificate and previous drawing-office experience.

Appointments are to permanent staff.
Staff Pension and Profit-Sharing Schemes.
Five day/39-hour week. Recreation Club with good sporting facilities.
Housing assistance possible in approved cases.

Write for application form to : Staff Officer, IMPERIAL CHEMICAL INDUSTRIES, LIMITED, Wilton Works, Middlesbrough, quoting advertisement reference ICI/X/243/b.

E5294 A

ASSISTANT SUPERVISOR for a West Country factory steam and power raising plant. The plant concerned is raising 100,000 lb./hr. of steam on water tube boilers and generating 3,000kW on pass out sets. Applicants must be sound and practical and be able to demonstrate ability to run the plant, to supervise and to take complete charge as and when necessary. Applicants should also have a sound basic general education with appropriate technical qualifications. Preference will be given to candidates holding a similar position today. Write stating full particulars and salary required.—BOX No. E5365, "The Engineer." A

ASSISTANT WORKS ENGINEER.—An engineer with good practical experience and the H.N.C. qualification is to be appointed to assist and deputise for the works engineer of a multiple-process factory in Birmingham using heavy plant in the manufacture of metals. Pension scheme, canteen, sports club. Holidays this summer by arrangement. Applicants should give full details of their careers and state the salary desired. All replies will be treated as strictly confidential.—BOX No. A.32, T & G, 167, High Holborn, London, W.C.1. E5312 A

AUTOMATION

Major industrial organisation, setting up Research and Development Laboratories in the Birmingham area, has the following vacancies :

(1) SENIOR PROJECT ENGINEER, starting salary £1800 to £2500 per annum, depending on age and qualifications. Candidates should have experience of Research and Development in connection with electronic computors, business machines and data transmission equipment.

(2) RESEARCH ENGINEERS, starting salary £1100 to £1500, according to age and qualifications.
Candidates should be between 30 and 45 years of age, and either have had experience of Research and Development in some branch of electrical or mechanical engineering, or have had experience in the design of precision mechanical equipment, preferably machine tools. Experience of automatic control systems will be advantageous, but it is not essential.

(3) JUNIOR ENGINEERS, starting salary £500 to £1000. Candidates should be 23–30 years of age, and should either have a good Honours Degree in Science, Engineering or Mathematics, or a good engineering training combined with Graduate Membership of a recognised Institution. Research or development experience is not essential, but will be advantageous.

Successful candidates will be expected to join the organisation's contributory superannuation scheme. Reasonable removal expenses will be paid.—BOX No. E5463, "The Engineer." A

BAHRAIN PETROLEUM COMPANY, LTD.
Applications are invited from GRADUATE ENGINEERS for the following vacancies in an expanding organisation :—
(a) CHEMICAL ENGINEERS, preferably experienced in design of pressure vessels, distillation columns, heat exchangers, pumping installations, &c., as encountered in petroleum refineries or other heavy chemical industrial plants. Recent graduates accepted to train for advancement.
(b) MECHANICAL ENGINEERS, with similar experience to (a). Recent graduates also being accepted for these posts.
(c) CIVIL ENGINEERS (Structural), with experience in design of steel and R.C. supporting structures and buildings. Recent graduates also accepted.
Salaries according to qualifications and experience, with adequate living allowance, medical attention and air-conditioned quarters in addition. Pension scheme and kit allowance. Living costs are low and savings high. Age limits 23 to 35. Apply, with fullest particulars, qualifications and experience.—BOX No. E724, "The Engineer." A

BAKELITE, LIMITED, Redfern Road, Tyseley, Birmingham, 11, have vacancies for Draughtsmen for work in connection with plant design, installation and layout ; some experience in the design of chemical plant desirable. Good working conditions, good prospects and rates of pay for right type of man. Staff pension scheme in operation.—Will applicants please write, giving full details of age, experience &c., to Labour Department Superintendent. E5386 A

BAKER PERKINS LIMITED.—Designer. A vacancy exists on the staff for a man of ability and initiative to engage on work of a wide variety in the chemical machinery department. This is an excellent opportunity for an ambitious, well-qualified technician. Technical qualifications to Higher National Certificate or equivalent. Salary according to experience.—Replies, stating details of education, training and qualifications, should be addressed to the Personnel Manager, Westwood Works, Peterborough, and will be treated in strict confidence. E5401 A

BAKER PERKINS LIMITED.—Designer-Draughtsman. Opportunity provided by expansion programme for men with at least 5 years' drawing-board experience, aged from 27–35 years. Experience of grinding or centrifugal or mixing machinery a particular advantage, but not essential. Applicants must have experience of general engineering and technical qualifications to Higher National Certificate or equivalent. Salary according to experience, ability, &c.—Replies, stating details of education, training and qualifications, should be addressed to the Personnel Manager, Westwood Works, Peterborough, and will be treated in strict confidence. E5399 A

BAKER PERKINS LIMITED.—Draughtsmen are required by this old-established engineering firm. Applicants should have at least three years' drawing-board experience and be interested in general mechanical problems. They should have served an engineering apprenticeship and have technical qualifications to National Certificate standard (Mechanical Engineering) or equivalent. Good conditions of employment, pension, life assurance and profit-sharing schemes after two years' continuous service.—Please reply, stating details of education, training and qualifications, to the Personnel Manager, Westwood Works, Peterborough. E5398 A

BAKER PERKINS LIMITED.—Young Designer. An opportunity exists with scope for gaining experience and advancement in expansion programme on a wide range of mechanical handling and process machinery in chemical and food industries. Applicants must have experience of general engineering and technical qualifications to Higher National Certificate, or equivalent. Salary according to experience, ability, &c.—Replies, stating details of education, training and qualifications, should be addressed to the Personnel Manager, Westwood Works, Peterborough, and will be treated in strict confidence. E5400 A

For continuation of small Advts., see page 6

SITUATIONS VACANT

NOTIFICATION OF VACANCIES ORDER, 1952

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive, unles he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

BELGIAN CONSULTING ENGINEERS invite applications for vacancies in their Brussels and Baghdad offices for two qualified engineers.

For Brussels office : one ELECTRICAL ENGINEER for planning and design of transmission lines and distribution stations, including drawing up of specifications and contract documents.

For Baghdad office : one ELECTRICAL ENGINEER, preferably also with mechanical engineering qualifications ; duties as for Brussels, but will also be engaged in construction of steam power stations.

Qualifications : University Degree or equivalent and/or membership of professional institution, coupled with practical experience.

For both posts a knowledge of the appropriate British Standards is required.

Perfect knowledge of English language essential, knowledge of French desirable.

Appointments will be in the first instance for three years with possibility of extension.

Applications, giving full details of qualifications and experience, should be addressed to the SOCIETE DE TRACTION ET D'ELECTRICITE, 31, Rue de la Science, BRUSSELS, BELGIUM. E2324 A

BOOTS PURE DRUG CO., LTD., require a young Mechanical/Electrical Engineer of at least H.N.C. or preferably Degree standard for the instrument and meter section of their engineering department at Nottingham. This position, which is permanent and pensionable, calls for both theoretical knowledge and practical experience of the installation, calibration, operation and maintenance of instruments and automatic controls used in modern industrial air conditioning, heating and power plants and of the meters used for the costing of engineering services. The commencing salary would depend on age, qualifications and experience. The company normally works a five-day week.—Applications in own writing, giving full details of career to date, should be addressed to the Personnel Manager, Station Street, Nottingham. E5286 A

BRITISH CELLOPHANE LIMITED, Bridgwater, Somerset, seeks Senior and Junior Draughtsmen, for both permanent and temporary appointments, for work on machine design and chemical plant layout. Applicants should possess at least O.N.C. and have had three years' shop experience. Five-day week, pensions fund scheme for permanent appointments. The temporary appointments are for a period of approximately two years' duration, subject to three months' notice and include generous subsistence allowances and periodic home return rail fares. Assistant Engineers, age 23/30 (permanent), also required. Applicants should have an Honours Degree in Mechanical Engineering and have had some practical works experience. The duties will be on development, improvement and maintenance of chemical and other plant.—Write to the Personnel Officer, stating full particulars and salary required, and quote Ref. No. E.30.Er. E5068 A

BRITISH PETROLEUM COMPANY LIMITED requires Engineers or Physicists with 1st or 2nd Class Honours Degrees, for experimental work on internal combustion engines including gas turbine engines and motor vehicle engines of high performance. Previous practical experience is not essential, but applicants should have a keen interest in this type of work. Age preferably not above 33. Salaries within the range £600 to £1200 per annum, according to qualifications and experience.—Write giving full details, quoting H.3299, to Box 7769, c/o, 191, Gresham House, E.C.2. E5442 A

BRITISH PETROLEUM COMPANY LIMITED require Planning Engineer for work in their London office. Work involves planning and co-ordination of design, supply and construction and the preparation and progress of detail programmes and schedules. Applicants must have at least Higher National Certificate and have served engineering apprenticeship with subsequent experience in the planning, design or construction of medium or heavy chemical or oil plants. Age 30–40. Non-contributory pension scheme, luncheon club. Salary according to age, qualifications and experience.—Write, giving full details, including age, quoting H.3396, to Box 7781, c/o 191, Gresham House, E.C.2. E5444 A

BRITISH PETROLEUM COMPANY LIMITED require two Plant Inspectors for employment initially in London office but later in U.K. or possibly overseas refinery. Applicants, aged 25–35 years, must have served full apprenticeship, preferably with firm manufacturing boiler or pressure vessels, and have had several years' practical experience in operation and maintenance of steam boilers or pressure vessels. 1st Class B.O.T. (Steam) Certificate or A.M.I.Mech.E. essential. Salary according to age, qualifications and experience. Non-contributory pension scheme. Luncheon club facilities.—Write, giving full details quoting H.3407, to Box 7784, c/o 191, Gresham House, E.C.2. E5443 A

CHEMICAL AND MECHANICAL ENGINEERS with experience in design of plant for continuous operation (preferably with knowledge of Oil Refinery or Petrochemical practice) or with knowledge of, and interest in, Nuclear Engineering, required by consultants with headquarters in London. Write in confidence, giving age, qualifications and experience.—BOX No. E5288, "The Engineer." A

CHIEF DESIGN DRAUGHTSMAN degree or equivalent mechanical engineering required by small engineering company 30 miles North London. Experience in vacuum pumps and air compressors desirable. Young men capable of accepting responsibility for design office are invited to apply for this post and give age, experience and salary required to—General Manager, The Cooper-Stewart Engineering Co., Ltd., Letchworth, Herts. E2329 A

BROOKE BOND & COMPANY, LIMITED, require an experienced Mechanical Engineer, to serve as assistant in their overseas engineering and research department. The department is engaged in the design and improvement of machinery for the manufacture of tea, also the designing and layout of tea estates factories embodying standard machinery. This work calls for a wide knowledge of engineering subjects, especially that of drying. The applicant would do well to realise that the department is a small unit, necessitating a great deal of drawing-office work. To be successful he must be prepared to adapt himself to many duties. Experience in business routine would be an advantage, since it is often necessary to conduct technical inquiries in connection with the buying of all classes of engineering supplies. A good salary and excellent prospects will be offered to the applicant who has the requisite training and experience and who wishes to make a career in the field of tea manufacture and the relevant machinery. The position offered might, in the course of time, carry with it the probability of short visits to our overseas tea estates, with a view to gaining experience of operating conditions.—Replies to be addressed to the above Department at Goulston Street, Aldgate, London, E.1, giving fullest details. E2281 A

BRUSH ELECTRICAL ENGINEERING CO., LTD., invites applications from qualified Engineers for the position of Chief Engineer of the Steam Turbine Division of Loughborough. The duties include responsibility for research, development, design drawing and testing and an extensive programme of development exists in all these aspects. Considerable experience of steam turbine engineering in industry is essential, coupled with high standards of administrative ability and appropriate educational qualifications. The appointment is permanent and will carry remuneration, status and superannuation benefits commensurate with the responsibilities involved.—Please write, with full details in confidence, to the Technical Director, Loughborough. E5419 A

JOHNSON AND PHILLIPS, LTD.,
CABLE WORKS MANAGER

Johnson and Phillips, Ltd., require a MANAGER for their Paper and Rubber Cable Works. Those interested should send full details of their training and career to the Managing Director. All correspondence will be treated in absolute confidence.

Johnson and Phillips, Limited,
Charlton, London, S.E.7. E5095 A

CHEMICAL ENGINEERS are required by an established company manufacturing intermediates for the plastics industry. Applicants, aged 23–28, should have a sound academic background and be able to apply their knowledge to the problems arising in the operation and development of chemical plant. The vacancies are in the technical department and the work will involve experimental investigations leading to the design and subsequent commissioning of new or modified process equipment. The work is varied and will appeal to men who wish to extend their experience without specialising in a narrow field. Applications, giving relevant details, which will be treated as confidential, should be addressed, quoting ref. R.86.—BOX No. E2287, "The Engineer." A

CHIEF ENGINEER, with wide experience in the design and construction of iron and steelworks, is required by the Metallurgical Equipment Export Co., Ltd. He will be required to supervise an engineering organisation undertaking a number of important contracts involving the construction of large metallurgical installations. The Company's headquarters are in London, but occasional travelling abroad and close co-operation with the engineers of several of the most important manufacturers of heavy metallurgical equipment within Great Britain will be required. A good salary will be paid. The work will be most interesting and of great importance to British export trade. All applications will be regarded as confidential.—Apply BOX No. E2346, "The Engineer." A

CHIEF INSPECTOR required for medium/heavy engineering concern in the Preston area. Applicants must have served an engineering apprenticeship and be capable of inspection and supervision of staff in departments concerned with machining and erecting to very close limits. Please supply details of age, experience and qualifications.—BOX No. E5464, "The Engineer." A

CHIEF JIG AND TOOL DESIGNER, aged about 35, qualified A.M.I.Mech.E. or A.M.I.P.E., required by reputable London Company. Permanent appointment, commencing four-figure salary. Applicants must have had comprehensive practical toolmaking experience and be thoroughly conversant with designing of jigs, tools and fixtures for light/medium precision engineering. Apply giving in confidence outline of qualifications and industrial history.—BOX No. E5204, "The Engineer." A

CHIEF JIG AND TOOL DESIGNER required by firm of Electronic Instrument Manufacturers. Applicants should have sound knowledge of press tools, jigs, fixtures, &c. connected with electronic instruments and light mechanical engineering, quantity and batch production. No age limit. Superannuation scheme.—Apply in writing with full details of past experience, salary required and when available to British Communications Corporation, Ltd., Exhibition Grounds, Wembley. E2332 A

CIVIL ENGINEER (ASSISTANT), age 25 to 30. Applicants must have a Degree and experience of the design and construction of heavy plant foundations and structures, including reinforced concrete. Pension fund and profit-sharing bonus. Good salary.—Apply, with full details of age, training and experience, to the Chief Engineer, A.P.C.M., Ltd., Portland House, Tothill Street, London, S.W.1. E5411 A

CIVIL ENGINEERING ASSISTANTS required by Head, Wrightson and Co., Ltd., for office work in the preparation of design drawings and contract documents for the construction of reinforced concrete foundations, structures and buildings for heavy industrial installations. Excellent working conditions ; 5-day week ; pension scheme.—Applications, stating age, qualifications and salary required, to Personnel Manager, Ref. MK/8, Teesdale Iron Works, Thornaby-on-Tees. E5488 A

CIVIL ENGINEERING ASSISTANT required for Service in the Middle East. Basic salary up to £1000 per annum according to experience. Apply stating age and full details of experience to—BOX No. E5520, "The Engineer." A

CIVIL ENGINEERS required for various sites in the U.K. Some experience essential.—Write, giving details of age, education, qualifications and salary required, to George Wimpey and Co., Limited (R. G. Head), 27, Hammersmith Grove, London, W.6. E5424 A

CIVIL ENGINEERS required by consultants with offices in Glasgow for work on large hydro-electric projects and steam power stations. Vacancies exist for Assistant Engineers, to be engaged on design and also on site supervision. Applicants must have passed or be exempt from Parts I and II of the Associate Membership examination of the Institution of Civil Engineers. Apply by letter with particulars of age, qualifications and experience.—BOX No. E745, "The Engineer." A

CONSTRUCTIONAL ENGINEERING COMPANY with headquarters in London require Senior Construction Engineers for contracts throughout U.K. and abroad. Those selected will be expected to control contracts of substantial value and will be responsible for the supervision of the work of foremen of all trades, both civil and mechanical, as well as the normal administrative work of a civil engineering contract, including costs, control of materials, planning and progress. Previous experience in a similar capacity is essential to obtain top salary and allowances. Write giving full details. —BOX No. E5415, "The Engineer." A

CONSULTING ENGINEERS require the following staff for the supervision of an important pipeline project in the Middle East : (a) Deputy Resident Engineers ; (b) Assistant Engineers. (a) Age range 35–45. Applicants should be fully qualified Civil Engineers and possess experience of this type of work. (b) Age range 25–35. Applicants should be qualified Civil Engineers with some site experience. Successful applicants would be required to work for a period in the London office before proceeding to the Middle East. Good pay and liberal leave on full pay on completion of contract.—Apply, stating name of paper, with full particulars of age, qualifications and experience, to Box No. 8822, c/o Charles Barker and Sons, Ltd., 31, Budge Row, London, E.C.4. E5397 A

CONSULTING ENGINEERS require, in their Newcastle upon Tyne office, Civil Engineers, Designer/Draughtsmen, Detailers, Senior and Junior, for interesting work in connection with the design of steam generating stations and development work in connection with nuclear energy generating stations covering a wide range of foundations, reinforced concrete and general civil engineering work. Five-day week ; pension scheme ; good working conditions. Applications treated in confidence.—State full details of qualifications and experience to Merz and McLellan, Carliol House, Newcastle upon Tyne, 1. E5453 A

CRAWLER TRACTOR SPARES.—Sales Representative with sound technical background and existing contacts in the trade required to develop market in high-quality spare parts. This is a first-class opportunity for the right man. Please write in first instance, giving full details of experience and salary required.—BOX No. E2279, "The Engineer."

CROMPTON PARKINSON, LTD., require both Senior and Junior Draughtsmen at their Chelmsford Works. Applicants should have either contract, development or diagram experience on switchgear up to 11kV, although men with general electrical or mechanical experience will be considered. Ideal terms of employment.—Apply, giving full particulars, to the Personnel Officer. E9976 A

DESIGN AND DEVELOPMENT ENGINEERS

are invited to apply to the British Tabulating Machine Co., Ltd., Letchworth, Herts, for interesting positions on electro-mechanical design and development in the Technical Division of the company, who are manufacturers of "HOLLERITH" high-speed electro-mechanical and electronic punched card accounting and statistical machinery.

Qualifications required include a University Degree, Higher National Certificate or equivalent. Previous shop and design experience preferred.

These are permanent positions in an expanding organisation, which to-day employs over 5000 people. Salary will be commensurate with experience and qualifications. Pension fund and sick pay facilities. Travel expenses for interview will be paid.—Write in first instance to Personnel Superintendent, quoting reference E/628. E737 A

DESIGN DRAUGHTSMAN.—Progressive engineering company in Scotland, now expanding its activities, has vacancy for Design Draughtsman with experience in the design of centrifugal pumps. Applicant should be capable of producing new designs of pumps for land and marine work. Working conditions are good. The position would be permanent, superannuated and offers scope for advancement to suitable man. Please reply, stating age, qualifications and experience.—BOX No. E5498, "The Engineer." A

DESIGNER required for development of small electro-mechanical devices, embodying magnetics and hydraulics. A sound knowledge of tooling methods and design for production is essential. Emphasis is laid upon the possession of practical experience and initiative rather than high academic achievement. S.E. London area. A substantial salary will be paid to the successful applicant. Reply fully in strict confidence stating age and experience.—BOX No. E2338, "The Engineer." A

DRAUGHTSMAN, Electrical, required for work on varied works distribution layout designs in connection with Cement, Brick and Tile manufacturing plants. Complete installations from substation to motors up to 800 h.p. including controls, cabling and distribution ; knowledge of ordering an advantage. The post is permanent and a pension scheme is in operation. Applicants should be of at least National or Higher National standards, and have had sound practical and drawing office experience. Starting salary up to £800 per annum according to ability. Write stating experience and qualifications to—The Chief Engineer, Eastwoods, Ltd., 158/160, City Road, London, E.C.1. E2326 A

DESIGNER-DRAUGHTSMAN required [illegible] London H.O. of a firm of reinforced concrete [illegible] neers and contractors. Applicants should be qu[illegible] fied and possess experience of building frame de[illegible] and knowledge of precast and prestressed conc[illegible] construction. The post is permanent and pensi[illegible] able. Two weeks' holiday allowed this year. Sa[illegible] according to qualifications and experience. Write [illegible] particulars.—BOX No. E738, "The Engineer."

DESIGNERS AND DRAUGHTSMEN

are invited to apply for a number of interesting vacancies with

THE ENGLISH ELECTRIC CO.'S

GUIDED WEAPONS DIVISION

at STEVENAGE and LUTON

as follows :—

DESIGNER DRAUGHTSMAN, for design and layout of high efficiency light alloy structures. Good knowledge of materials and manufacturing technique is essential. Ref. 2810.

DETAIL DRAUGHTSMAN, for light mechanical work associated with aircraft structures and installation of special components. Knowledge of electrical and hydraulic systems an advantage. Ref. 2811.

DESIGNER DRAUGHTSMAN, for design of experimental rigs to test high efficiency light alloy structures. Applicants should be able to do simple stressing and be qualified to at least O.N.C. (Mech.) standard. Progressive appointments assured to man of ability.

DESIGNER DRAUGHTSMAN, for work on precision electro/mechanical instruments and gyroscopes. Experience of design for close tolerance manufacture or die casting an advantage. Ref. 1494.

DRAUGHTSMAN/CHECKERS, with approximately five years' drawing-office service, together with specialist knowledge in electronic, instrument, electrical or mechanical engineering and hydraulics. Ref. 2802.

These positions carry attractive salaries and promotion prospects and are pensionable after qualifying period. Successful candidates from the Greater London area can be given housing assistance.—Applications to Dept. C.P.S., 3367 Strand, W.C.2, quoting Ref. No. 1067B. E5313 A

DEVELOPMENT ENGINEER

A Senior Engineer is required to lead a team of engineers engaged on the development of mechanical sensing elements. Previous industrial experience in the measurement of stress and other physical quantities would be an advantage. The post offers considerable scope for an enthusiastic leader of initiative. Applicants should detail their age, experience and salary required.—BOX No. E5500, "The Engineer."

DEVELOPMENT ENGINEERS AND TECHNICIANS required in Research Department of well-known firm of precision engineers, particularly for work in connection with servo systems, small precision motors and gyroscopic instruments. Apply stating age, experience and salary required to S. G. Brown, Ltd., Shakespeare Street, Watford, Herts. E746[illegible]

DRAUGHTSMAN, for engineering department of a weldless steel tube works, wanted for interesting work on design and development of plant. Experience of this class of work required. Pension scheme &c. Permanent position for suitable applicant. Apply, stating age, experience and salary required, to Personnel Manager, Tubes, Limited, Rocky Lane, Aston, Birmingham, 6. E5385

DRAUGHTSMAN, General Engineering and Mining Machinery.—Applications, giving full particulars of experience, age and salary required, to the Secretary, The Uskside Engineering Co., Ltd., Newport, Mon. E2255

DRAUGHTSMAN required by The British Aluminium Company, Ltd., at their Rolling Mills, Milton, Stoke-on-Trent. Duties will cover work on the maintenance of melting shop and rolling mill plant, equipment and services, together with some design and development. Previous experience in these fields not essential. Upper age limit about 35. Minimum technical qualifications O.N.C. Canteen facilities, superannuation scheme.—Apply by letter (in confidence), stating age, training, qualifications and experience, to the Manager, at the above address. E5316

DRAUGHTSMAN required in the engineering department of a well known cement, brick and tile manufacturing company. Knowledge of industrial plant layout essential ; experience in the design and layout of cement and brickmaking plant ; mechanical handling equipment and structural steelwork an advantage. The post is permanent and a pension scheme is in operation. Applicants should be of at least National or Higher National standards and have had sound workshop and drawing office experience. Starting salary up to £800 per annum according to ability. Write stating experience and qualifications to—The Chief Engineer, Eastwoods, Ltd., 158/160, City Road, London, E.C.1. E2327

DRAUGHTSMAN with general experience in light engineering required. Interesting design work on special production jigs and automatic machines. Write with full particulars of experience.—Stabilo Radio Components Ltd., Commerce Estate, Ray Road, E.18. E535[illegible]

DRAUGHTSMAN with good mechanical engineering experience required for interesting and important research and development work. Excellent opportunities for advancement. Age 25/30 years.—Apply in writing, giving full particulars of experience and qualifications, to Dowsett Engineering Construction Ltd., Tallington, Stamford, Lincs. E542[illegible]

DRAUGHTSMEN AND DRAUGHTSWOMEN, experienced, for light structural steel work, sheet metal ducting, and plate work. Good prospects and conditions, five-day week, pension scheme, holiday this year. Write—Visco Engineering Co., 161, Stafford Road, Croydon. E5183

SITUATIONS VACANT

DRAUGHTSMEN

APPLICATIONS ARE INVITED for the following appointments at the CLAYDON, SUFFOLK works of THE BRITISH STEEL PILING CO., LTD.

STRUCTURAL DESIGNER DRAUGHTSMAN (Minimum qualifications H.N.C. or equivalent).

MECHANICAL DESIGNER DRAUGHTSMEN (Minimum qualifications H.N.C. or equivalent).

One of these vacancies is open to a suitably qualified candidate for work on Research and Development.

JUNIOR MECHANICAL DRAUGHTSMAN (Minimum qualifications O.N.C.).

Experience should preferably (but not essentially) include equipment such as cranes, hoisting machinery (steam, diesel, electric), mechanical handling equipment, contractors' plant.

THESE ARE PROGRESSIVE PERMANENT POSITIONS IN AN EXPANDING ORGANISATION and candidates for the senior posts should be capable of accepting responsibility for complete projects.

The Company operates a contributory pension scheme and good canteen facilities exist.

Salary will be in accordance with age, qualifications and experience.

Applications in the first instance to Works Manager at the above address. E5201 A

DRAUGHTSMEN—Bexford, Ltd., Brantham, Nr. Manningtree, Essex, require first-class Senior and Junior mechanical design and detailing draughtsmen, for interesting work over a wide field on the design and development of machinery for the manufacture of photographic film base. Salaries of the order of £12 12s. per week, or over to men with good training and experience. Permanent position. Contributory pension scheme.—Please write, giving details of age, training and experience, to the Personnel Manager, Bexford, Ltd., Brantham. E5210 A

DRAUGHTSMEN, experienced, required for work on coal preparation plants. Vacancies exist for Project Designers, Mechanical, Structural, Pipework, Material Handling and Electrical Draughtsmen. Five-day week. Pension scheme in operation. London area.—Write, The Coppee Co. (Great Britain), Ltd., 140, Piccadilly, London, W.1. E5492 A

DRAUGHTSMEN—BX Plastics, Ltd., Brantham Works, Nr. Manningtree, Essex, have the following vacancies for draughtsmen: (1) At Brantham Works—draughtsmen with broad mechanical engineering background and training. Good Salaries to men of proved ability. (2) At the research station, Lawford Place, Nr. Manningtree—a draughtsman designer for work in connection with Plastics Processing Plant. Experience in this field is desirable but not essential. Applicants, aged 28 to 35, should possess Ordinary or Higher National Certificate, and experience of small precision engineering.—All applications for the above vacancies should be made to the Personnel Manager, at Brantham Works, giving details of age, training and experience. E5209 A

DRAUGHTSMEN for eventual promotion to Engineers. Must be experienced in power station mechanical and electrical layout work in drawing office and on site. Location of work, London. Good salaries are offered. Five day week. Non-contributory pension scheme. Upper age limit 35. DRAUGHTSMEN experienced in power station layout work. Location of work, London. Good salaries plus annual bonus. Five day week. No upper age limit. This year's holiday arrangements will be honoured—BOX No.E2348, "The Engineer."

DRAUGHTSMEN (Intermediate) required for equipment design and tooling for gear cutting machinery. Applicants should have had practical training and knowledge of jig and tool design.—Applications stating age, qualifications and salary required, to The Personnel Officer, W. E. Sykes Ltd., Manor Works, Staines, Middlesex. E5377 A

DRAUGHTSMEN

Owing to further rapid expansion LOUIS NEWMARK, LTD., have the following vacancies at: NEW ADDINGTON.—DESIGN and DETAILING DRAUGHTSMEN for the design drawing-office of their aircraft instrument division for work on small mechanical devices.—Apply, Vulcan Way, New Addington.

CROYDON.—DRAUGHTSMEN experienced in design and detailing of jigs and tools. Experience of press tools an advantage.—Apply, Prefect Works, Purley Way, Croydon, Surrey. Pension scheme, excellent working conditions, &c. E5491 A

DRAUGHTSMEN required for Diesel Electric and Diesel Power-Pack layouts for tendering purposes. Wide experience of this work essential. Some marine experience useful but not essential. Holiday commitments honoured. Superannuation scheme; five day week.—Apply Personnel Manager, North British Locomotive Co., Ltd., Springburn, Glasgow, N.1. E5532 A

DRAUGHTSMEN required for N.W. London area. Experienced in design and layout of medium heavy industrial plants, general pipework or mechanical design. Permanent employment with good salary according to ability, pension scheme. Five day week and three weeks annual holiday. Own staff advised of this advertisement. Write stating experience and salary required.—BOX No. E5523, "The Engineer."

DRAUGHTSMEN.—The long term expansion of a well established engineering company in a West of London suburb calls for men with Jig and Tool experience, preferably on heavy press tools. Attractive commencing salaries will be paid. Permanent progressive employment is assured. Superannuation fund. Apply giving fullest details in strict confidence.—BOX No. E5529, "The Engineer." A

DRAUGHTSMEN (Senior and Junior) required for work in connection with the following branches of coke oven and gasworks plants:—
(a) Mechanical and By-Product Plant.
(b) Pipework.
(c) Reinforced Concrete Bunkers and Foundations.
(d) Steelwork for Buildings and Conveyors.

Applicants should be competent men able to work with the minimum of supervision. Technical qualifications to O.N.C. or beyond. Good remuneration and prospects for capable men. Pension scheme. Five-day week; canteen facilities.—State age and experience to the Personnel Officer (D.O.), Woodall-Duckham Construction Company, Ltd., Woodall-Duckham House, 63–77, Brompton Road, London, S.W.3. E672 A

DRAUGHTSMEN

SIMON-CARVES LTD.

have additional vacancies at their Cheadle Heath and North Manchester offices for Draughtsmen with experience in the following fields:

(a) Pipework arrangement.
(b) Structural steelwork.
(c) Reinforced concrete Industrial structures.
(d) Refractory brickwork.

Working conditions and scope are good and a pension scheme is in operation. A successful candidate living outside the Manchester area will be helped with removal expenses. Starting salaries will depend on qualifications and experience; for senior men they will range up to £750.—Write (quoting ref. CJ29) to Staff and Training Division, Simon-Carves, Ltd., Cheadle Heath, Stockport. E5470 A

DRAUGHTSMEN WITH FAN ENGINEERING EXPERIENCE WANTED and consideration given also to young engineering draughtsmen with plant experience, wishing to enter interesting, progressive industry. The positions are permanent and covered by pension/life assurance schemes. Salary according to qualifications and experience. 5 day week. Commencing date to suit existing holiday arrangements.—Reply fully to Keith Blackman, Ltd., Mill Mead Road, London, N.17. E752 A

ELECTRICAL & MECHANICAL ENGINEER.—Sunvic Controls, Ltd. (a subsidiary of Metropolitan-Vickers Electrical Co., Ltd.), have the following vacancy in their new development and production units at Harlow.

Graduate Engineer with experience in the development or operation of pneumatic or hydraulic control equipment. Applicants should have some knowledge of the servo problems connected with process control instrumentation.

The above position is permanent and offers excellent prospects for promotion in a team engaged on the development and manufacture of a wide range of new instruments. Salary will be in accordance with age and ability. The company's contributory pension scheme applies, and housing is available, if required.

Reply in writing, giving full particulars of age, experience, qualifications and present situation, to Chief Engineer, Sunvic Controls, Ltd., Harlow, Essex. E694 A

ELECTRICAL BUYER required for London Office of merchant company operating in Africa and the Middle East. Must be familiar with installation materials and equipment and have had experience with electrical contractor or wholesaler. Some technical knowledge and experience with radio and domestic appliances would be added advantage. Commencing salary £800.—Reply to Box No. 8831, c/o Charles Barker and Sons, Ltd., 31 Budge Row, London, E.C.4, giving age, present salary, qualifications and brief summary of experience. E5412 A

ELECTRICAL MAINTENANCE ENGINEER wanted by large industrial concern in British East Africa. Should have served a recognised apprenticeship, must be able to take responsibility for maintenance and installation of new equipment. Preference given to men in the age group 23/30 years. Four year tour with four months' paid leave. Free passages. Superannuation and medical benefits. Salary commensurate with experience and qualifications.—Write Box. JN/85, c/o 95, Bishopsgate, E.C.2. E5413 A

ELECTRIC FURNACE CO., LTD., requires young engineers for interesting work on all types of electric furnaces and induction heating equipment. Applicants should preferably have an engineering degree or equivalent qualifications. Some practical engineering experience desirable. Commencing salary will depend on age, qualifications and experience, but will be in the range £650/800 per annum.—Applications to Chief Engineer, Electric Furnace Co., Ltd., 161, Queens Road, Weybridge, Surrey. E2272 A

For continuation of Small Advts., page 8

BOOKS and PUBLICATIONS

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COMPANY MEETING

IMPERIAL CHEMICAL INDUSTRIES

RECORD GROUP SALES

The 28th annual general meeting of Imperial Chemical Industries, Ltd., was held on June 16th in London.

Dr. Alexander Fleck, the chairman, in the course of his speech said :—The consolidated sales of the Group, after deducting the value of the sales made by our new subsidiaries, have increased from £282 millions to £327 millions—an increase of £45 millions or 16 per cent. over the figure for 1953, itself at that time the highest in our history. The Company's home sales and direct exports each increased by approximately the same percentage.

I should like most specially to draw your attention to the table of price indices in which the changes in home trade prices of the Company's products are compared with other significant indices. I am sure you will agree that the comparison shows the Company's prices in a very favourable light. Since 1938 the cost of our raw materials has risen by 272 per cent. and the earnings of our workers have risen by 202 per cent. For the same period The Board of Trade wholesale price index increased by 225 per cent. In comparison with these increases (each of which exceeds 200 per cent.) the prices at which I.C.I. sells its products in the home market have risen by only 91 per cent. This, I think you will also agree, shows the remarkable success which has attended the Company's policy of keeping its selling prices as low and as stable as possible. Low and stable prices encourage our customers to use more of our products, and as our products are used by many British industries, we believe that our price policy aids and supports the economy of the country as a whole.

Between 1953 and 1954 the Company's price index for home sales has moved up by one point only, and the increase in the value of our home sales during this period is therefore almost entirely due to increase in volume. The consequential increase in profit for 1954 is also attributable to increase in volume, coupled with improvements in efficiency due to Work Study and other factors.

The Company will continue this price policy and will aim not only at absorbing increased costs but, wherever practicable, at seeing that reductions in costs resulting from improved methods and greater efficiency are reflected in lower prices to its customers. Let me emphasise, however, that the price indices I have quoted are averages, and that it may not be possible in all cases to avoid an increase in price; in fact, I am sure that some readjustments upwards in some of our products will almost be inevitable. This is particularly so where raw materials, fuel and freight represent a large proportion of total costs. We are glad to play our part with others first of all in striving after methods of increasing productivity and then of passing on the results of such efforts. Contributions of this nature will, we hope, come from all branches of British industry. It is by such contributions, widespread as they should be, that each one of us must earnestly hope that effective action will soon be taken to prevent the inflation which is threatening to erode our material standards.

EXPORTS AND OVERSEAS INTERESTS

At £67½ millions the Company's exports were a record and showed an increase of 16 per cent. over the previous year. This increase in the value of exports represents a still greater rise in the volume of exports.

I regard this high export figure as a particularly significant feature of the year's trading, because it has been achieved in the face of keen competition from other major chemical producing countries and in spite of the strong demand for our products from the home market. Indeed, if indirect exports were included, it would be seen that more than 40 per cent. of the Company's production now goes abroad.

A number of our overseas companies are now substantial manufacturing entities, and when I tell you that the total turnover of the Company's overseas business (both local manufacture and imports from the United Kingdom) through subsidiary and associated companies is now approaching in value I.C.I.'s sales in the United Kingdom, I am sure you will appreciate how important our overseas interests are.

It is worthy of note that the net I.C.I. Ordinary dividend, requiring just under £8 millions, represents rather less than 37 per cent. of the net income of the year, £21¼ millions. Furthermore, this Ordinary dividend, requiring £14 millions before deduction of income tax, represents a return of 4·8 per cent. gross on an employed capital of £295 millions, which according to the Company's balance sheet is the employed capital belonging to the Ordinary stockholders.

CURRENT YEAR'S TRADING

As regards current trading, I am pleased to tell you that in 1955 we have so far experienced a period of great activity. The general level of both home and export sales is well above that of the corresponding period of last year. In fact, I do not think I can do better than repeat the words that I used to the stockholders last year and say that "So far this year the Company has enjoyed, in common with other industries in this country, a period of expansion, and the prospects are in general good."

This, of course, assumes that the very serious strikes which so gravely affect our national economy are not allowed to recur and that our united efforts can be successfully directed to minimising, if not eradicating, the deplorable setback which the country as a whole has suffered.

On the other side of the account, I would tell you that the increased level of sales this year, to which I have referred, is due to some extent to production now coming forward from new plants which have recently been completed. Competition, particularly overseas, is strong, but we are confident that, provided our prices do not have to be put up because of rising costs at home, we can meet this competition and make still further progress.

The report was adopted.

SITUATIONS VACANT

NOTIFICATION OF VACANCIES ORDER, 1952

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18–64 inclusive or a woman aged 18–59 inclusive, unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

ELECTRICAL ENGINEER.—Large Oil Company requires young qualified bachelor for service in Middle East. Substantial basic salary with allowances, pensionable service, good prospects, paid home leave.—Write quoting No. 526 to Box. No. 8838, c/o Charles Barker and Sons, Ltd., 37 Budge Row, London, E.C.4. E5416 A

ENGINEER, aged 30–40, with experience in the layout of complete conventional power stations, is required in the atomic energy department of The General Electric Co., Ltd., at Fraser and Chalmers Engineering Works, Erith, Kent. A University Degree and several years in a senior capacity in an organisation dealing with the above type of work is essential.—Apply, Personnel Manager, Fraser and Chalmers Engineering Works, Erith, Kent. E5375 A

ENGINEER.—Civil or Mechanical for Middle East. Experienced in oil refinery work. Used to working in fire hazard areas and able to appreciate the care which must be taken when cutting into live oil lines, dealing with storage tanks which have not been gas freed, etc. Attractive salary.—Apply Motherwell Bridge & Engineering Co., Ltd., Motherwell. E5446 A

ENGINEER, for well-known firm in the London area, with sound technical knowledge of all problems relating to natural, induced, forced draught water cooling towers and other forms of heat exchangers. Previous commercial experience also necessary. Only qualified engineers in this field can be considered. Good salary to right man; five-day week; pension scheme.—Write BOX No. E5460, "The Engineer." A

ENGINEER BUYERS AND REPRESENTATIVES' ASSOCIATION (Limited by Guarantee). The Council of this dominant professional organisation can fill vacancies for Engineer Buyers and Engineer-Representatives (no fees—employers or members)—and to consider applications for membership from qualified Buyers and Representatives associated with the Engineering and Allied Trades.—Write E.B.R.A., 49, Victoria Street, London, S.W.1. Tel.: ABB 3583 (Employment Licence No. 6063)—Licensed annually by the L.C.C. E627 A

ENGINEERING DRAUGHTSMAN DESIGNER for London office, workshop trained, at least O.N.C. standard, required for the design and planned layout of special factory plant. Candidates should have experience in one or more of the following: (a) steam, (b) conveying, (c) electrical wiring, (d) pipe layouts. Pension scheme and canteen.—Send age and particulars of training and experience in full to Staff (U.K.) Department, The United Africa Company, Limited, Unilever House, Blackfriars, London, E.C.4. E5255 A

ENGINEERING MANAGER: Post to be filled in London office of manufacturing and consulting firm. Work connected with gas turbines and atomic energy. Following desirable but all not essential:—B.Sc. or A.I.Mech.E.; experience in control of draughtsmen; ambition; apprenticeship. Preferred age 30/40. Starting salary £1,000–£1,500 depending on experience.—BOX No. E2323, "The Engineer." A

ENGINEERING STAFF required by international firm of oil consultants for work in Turkey. Duration of contract: minimum 1 year, possible 2 years. Suitable applicants will be interviewed in U.K. and attractive contract terms will be offered. Single men preferred, as follows:—

(1) Field Engineers for supervision of field operations connected with construction of oil pipelines and tank farms.
(2) Welding Inspectors (a) experienced in all forms of welded pipeline fabrication (b) experienced in field erection of tank farms.
(3) Doping and Wrapping Inspectors for pipelines. Must have experience of inspecting this work.

Qualified applicants should write fully, stating age and experience, to,—BOX No. 8840, c/o, Charles Barker and Sons, Ltd., 31, Budge Row, London, E.C.4. E5425 A

ENGINEER required for Inspecting and Expediting work by company specialising in design and construction of petroleum/chemical plant.—Address full details of career to Head Wrightson Processes, Limited, 24/26, Baltic Street, London, E.C.1. E5449 A

ENGINEER required in Birmingham area to assist Works Engineer in interesting work on all matters relating to plant development and maintenance. Minimum qualifications H.N.C. Good salary and prospects for suitable applicant. Superannuation scheme. Write the Secretary.—BOX No. E2286, "The Engineer." A

ENGINEERS AND PHYSICISTS.—The following vacancies exist in the Tyre Development Department of The Avon India Rubber Co., Ltd., Melksham, Wiltshire:—

1. An ENGINEER or PHYSICIST for work on product performance.
2. An ENGINEER for production control and liaison.
3. A PHYSICIST for basic research into tyre design and performance.

These appointments cover a wide and interesting variety of work in an expanding Company and offer considerable scope for men with initiative. An Engineering or Physics Degree is a minimum qualification, with vacancy No. 3 requiring an honours standard. Previous experience in the rubber industry is not essential and graduates without industrial experience will be considered.—For further particulars apply to the Secretary giving personal details and previous experience. E5341 A

ENGINEERS
NEWCASTLE UPON TYNE

Designers and Research Engineers are required for development work on new hydraulic machines, automatic controls and servo mechanisms. The work offers scope to mechanical and electrical engineers with a gift for invention and experimentation.

In replying give full details of experience and salary expected. Degree or H.N.C. with endorsements is necessary.

Applications should be addressed to Personnel Officer, Vickers-Armstrongs, Limited, Elswick Works, Newcastle upon Tyne, 4. E5452 A

ENGINEER.—Young, qualified Engineer required as Assistant to Managing Director of Midland works. Near future advancement in expanding business for capable, administrative engineer.—BOX No. E5408, "The Engineer." A

ENGINEERS, DESIGNERS AND DRAUGHTSMEN required for Mechanical Engineering Department of Sir Alfred McAlpine & Son, Limited., Hooton, Wirral, Cheshire. E2341 A

ESTIMATING AND PROCESS PLANNING ENGINEERS with sound knowledge in the fields of electronic and light mechanical engineering are invited to apply for a very interesting position. No age limit. Superannuation scheme.—Apply in writing with full details of past experience, salary required and when available to British Communications Corporation, Ltd., Exhibition Grounds, Wembley. E2331 A

ESTIMATING DRAUGHTSMAN for senior progressive position with prominent London firm of land and marine boiler engineers. Workshop experience an advantage, though not essential. Attractive salary commensurate with experience and qualifications.—Write fully, stating age, &c., to BOX No. 8803, c/o Charles Barker and Sons, Ltd., 31, Budge Row, London, E.C.4. E5254 A

ESTIMATOR required for light structural fabrications. Knowledge mechancial estimating an advantage. C.I., Ltd., Staffa Road, E.10. Tel.: LEY. 3678. E5447 A

ESTIMATORS (including Senior) required for work in London office of specialists in design and construction of petroleum and chemical plants. Five-day week, generous staff pension scheme, good salary.—Write full details of career to Head Wrightson Processes, Limited, 24/26, Baltic Street, London E.C.1. E5287 A

EXPERIENCED DESIGNER-DRAUGHTSMAN required to augment the Mechanical Engineering Department of Samuel Williams and Sons, Limited, Dagenham Dock, Essex. The work involves design and development of the Company's own bulk handling equipment, oil storage installation and general engineering. Candidates should have thorough technical training and preferably some shop experience. Canteen facilities are available and the position is permanent and superannuated. A house in good residential area available for suitable candidate. Salary from £750/£900 per annum. A vacancy also exists in the Drawing Office team for a Junior Draughtsman. Applications with full particulars of experience to the Personnel Manager. E5423 A

EXPORT SALES ENGINEER required. Preference given to applicant with knowledge of construction and earth moving equipment. Age 23/35—Apply in first instance in writing to Export Manager, Blaw Knox, Ltd., 90/94, Brompton Road, London, S.W.3. E5421 A

FORD MOTOR COMPANY LIMITED of Dagenham, Essex, are making industrial history again. We have a vast expansion scheme under way which has created the following opportunity in our Construction Engineering Department. An Assistant Engineer is required for project work on gas holders, boiler installations and general engineering. To qualify for this job you will need an A.M.I.Mech.E. backed by at least five years' experience of site erection and supervision. Does this opening appeal to you? Then our Salaried Personnel Department will be glad if you will write to them. Your starting salary will reflect your experience and qualifications and our excellent non-contributory pension will take care of your future security. Please quote reference KGA. E5434 A

FREE-LANCE REPRESENTATIVES required for
(a) Lancashire and Cheshire
(b) West Country and South Wales
To promote sales of high quality Precision Measuring Instruments and Gauges, and non-competitive portable tool.—Write Box 995, c/o Walter Judd, Ltd., 47, Gresham Street, E.C.2. E5524 A

GRADUATE CHEMIST OR PHYSICIST required to assist works chemist in large progressive company. Conditions are excellent with good salary and superannuation scheme. Applications, which will be treated in strictest confidence, should give adequate details in chronological order and should indicate initial salary expected.—Write giving full details to Personnel Manager, Thames Board Mills, Limited, Purfleet, Essex. E5489 A

GRADUATE CIVIL ENGINEER

Courtaulds, Limited, requires a recent University Graduate in Civil Engineering for site supervision and the design of works involving civil engineering, structural engineering and general building. Initial employment would be in North Lincolnshire, where a new factory is under construction. This would provide experience in piled foundations, reinforced concrete and structural steel construction as a preliminary to subsequent and pensionable employment mainly at the Company's Coventry Headquarters.

Candidates should write for a detailed form of application to the Director of Personnel, Courtaulds, Limited, 16, St. Martin's-le-Grand, London, E.C.1, quoting the reference number B.27. E5086 A

GRADUATES in Mechanical and Chemical Engineering required for progressive positions in the Research, Design and Production Divisions of The Power-Gas Corporation, Limited. Training given to men without previous industrial experience.—Apply to Staff Personnel Manager, Parkfield Works, Stockton-on-Tees. E741 A

HEATING AND VENTILATING of first class standard is a "must" in the modern factory. Ford Motor Company Limited, of Dagenham, Essex, require a first class draughtsman for an opportunity arising from their expansion. Are you the man for the job? You will need to be capable of designing heating and ventilating systems, and water, gas, steam and condensation services. Associate membership of the Institution of Heating and Ventilating Engineers will stand you in good stead. In return for your experience and qualifications we offer a commensurate starting salary, work of absorbing interest and participation in a first rate non-contributory pension scheme. Our salaried personnel department will be glad to hear from you. Please quote reference KHV. E5433 A

HEATING, VENTILATING, ELECTRICAL AND MECHANICAL ENGINEER required by consulting engineers to take charge as Chief Engineer of department specialising in such work applied chiefly to large buildings and factories. Commencing salary will be between £1200 and £1500, according to experience. This is a progressive position with good prospects of Partnership status after trial period. University Degree or equivalent qualification essential. Confidential applications, stating age and experience.—BOX No. E2295, "The Engineer." A

IMPERIAL CHEMICAL INDUSTRIES, LTD., Metals Division, has a vacancy for a Quantity Surveyor, aged 27/32. Preference will be given to a qualified chartered surveyor, but one in course of qualifying would be considered. The successful applicant would be expected to prepare full bills of quantities and assume full responsibility for final measurements and accounts on industrial projects. The post is a pensionable and progressive one.—Application forms may be obtained from Staff Manager, I.C.I. Metals Division, Kynoch Works, Witton, Birmingham, 6, quoting ENG/2. E5389 A

IMPERIAL CHEMICAL INDUSTRIES LIMITED,

WILTON WORKS,

ENGINEERS

MECHANICAL, ELECTRICAL, STRUCTURAL, CIVIL.

PERMANENT STAFF APPOINTMENTS await young Graduate Engineers with good Honours Degrees. The Wilton Works Site of 2000 ACRES IN COURSE OF DEVELOPMENT in addition to providing general and varied experience in modern Engineering, has its own special problems in design and materials.

The organisation is expanding and has opportunities for technical training followed by further training towards higher management.

Situated in the North Riding of Yorkshire, near the Coast, Wilton offers first-class working conditions, five-day working week, pension fund, and full recreational facilities.

Write for application form to Staff Officer, Imperial Chemical Industries Limited, Wilton Works, Middlesbrough, Yorkshire, quoting advertisement reference ICI/X/226/b. E9207 A

IMPERIAL CHEMICAL INDUSTRIES LIMITED,

Dyestuffs Division, has vacancies at Manchester and Huddersfield for

MECHANICAL,
ELECTRICAL,
CIVIL
and
STRUCTURAL ENGINEERING DRAUGHTSMEN

for design and detail work in connection with new projects for the manufacture of synthetic fibre forming materials and other organic chemicals. Basic minimum qualification required is O.N.C. (preferably H.N.C.).—Applications, with brief details of experience and qualifications, should be made to Staff Department, Hexagon House, Blackley, Manchester, 9. E5378 A

IMPERIAL CHEMICAL INDUSTRIES, LIMITED,
METALS DIVISION,
BIRMINGHAM,
has vacancies in its
RESEARCH DEPARTMENT
for
DESIGN DRAUGHTSMEN
to undertake work associated with

(1) the melting and fabrication of Titanium.
(2) the behaviour of non-ferrous metals during drawing, pressing, extrusion and similar processes and
(3) the provision of special purpose equipment required by the research department.

A wide variety of interesting problems is encountered in the work, all of which is associated with research and development projects. Successful applicants will be expected to supervise the manufacture of plant which they design and to participate in experimental tests. Candidates should possess a Higher National Certificate in Mechanical Engineering or an equivalent qualification. Commencing salaries up to £890 p.a. will be paid dependent upon age, qualifications and experience. Application forms may be obtained from Staff Manager, I.C.I. Metals Division, Kynoch Works, Witton, Birmingham, 6, quoting RES/3. E5462 A

INSTRUMENT MECHANIC required for research laboratory work. Applicants should have knowledge of electrical and mechanical equipment, especially of a prototype nature and be able to work from rough sketches. The job is one of varied interest for man with initiative and is permanent and pensionable. Apply in writing giving details of age and previous experience.—Monsanto Chemicals, Limited, Fulmer Hall, Fulmer, Nr. Slough, Bucks. E5468 A

JUNIOR ESTIMATORS required for London office of Sigmund Pumps Limited. Good prospects, pension scheme.—Write stating age, training and present salary to Home Sales Manager, Sigmund Pumps Limited, Team Valley, Gateshead, 11. E5410 A

INTERESTING VACANCY in expanding automatic control development section. Applicants should have a degree or H.N.C. in Mathematics, Physics or Engineering. Experience in application of mathematical analysis to engineering problems and process control would be useful, but the most important quality required is an interest in mathematics and the ability to apply it. Age about 22-30. Permanent position.—Apply Chief Instrumentation Engineer, Costain-John Brown, Ltd., Roxby Place, Seagrave Road, London, S.W.6. E5414 A

INTERESTING WORK AVAILABLE in modern drawing-office for Mechanical Engineering Draughtsmen and also Structural Designer Draughtsmen at steel works with large development programme. Applicants to state age, technical qualifications, experience and salary required, to Labour Manager, Samuel Fox and Co., Ltd., Stocksbridge Works, Near Sheffield. E5495 A

JUNIOR DRAUGHTSMEN, having completed National Service, required for work on large chemical plant installations; A.E.S.D. minimum rates or above. Five-day week and superannuation scheme.—Apply by letter, giving details of technical education, to the Chief Draughtsman, Laporte Chemicals, Limited, Clifton House, Euston Road, London, N.W.1. E734 A

JUNIOR GRADUATE ENGINEERS required for electrical "grid" construction under pioneering conditions in England and Scotland. Two-year progressive training period. Commencing salary not less than £550 p.a. minimum if leaving university considerably higher salary if experienced. Qualifications, good Degree and fitness standard. Excellent prospects, pension scheme.—Apply, Riley and Neate, Ltd., Winchester. E9120 A

LARGE OIL COMPANY requires experienced Buyer for West End Offices aged about 30-35 with knowledge of Civil Engineering equipment, machine tools, pumps, engines, etc. Pensionable post, salary between £1000 and £1200 according to qualifications and experience.—Write quoting No. 508 to Box No. 8844, c/o Charles Barker and Sons, Ltd., 31, Budge Row, London, E.C.4. E5427 A

LAURENCE, SCOTT & ELECTROMOTORS LTD.—Draughtsmen required at our Norwich works for the layout and detailing of medium electric motors and generators, &c. Experience preferred but not essential.—Apply to the Secretary. E5502 A

LEADING EAST ANGLIAN COMPANY OF MILLING ENGINEERS offers first-class opportunities in modern drawing-office to competent Draughtsmen with experience of layout work. Preference for men with experience of food processing machinery or with knowledge of mechanical or pneumatic conveying plant. Apply, stating age, experience and salary required.—BOX No. E2302, "The Engineer." A

LOUIS NEWMARK, LTD., have a vacancy in their laboratories for a Physicist or Electro-Mechanical Engineer, for development work on aircraft and allied instruments. Applications are invited from persons with a Degree or similar qualifications, who have had some industrial experience, preferably on work with gyroscopes or accelerometers. Good salary and prospects.—Apply, Personnel Manager, Louis Newmark, Ltd., Prefect Works, Purley Way, Croydon, Surrey. E9927 A

LOUIS NEWMARK, LTD., have vacancies in their expanding laboratories for young Engineers with Inter B.Sc., H.N.C. or Degree and some experience in electronics for work on automatic pilots and other electronic devices. Good salary and prospects.—Apply, Personnel Officer, Louis Newmark, Ltd., Prefect Works, Purley Way, Croydon, Surrey. E5091 A

MANAGER

Applications are invited for the position of Manager to a company carrying on the business of ship-repairing in Ireland.

Applications, enclosing copies of references and stating when available, should give particulars of age, qualifications, experience, and salary expected, and should be sent before July 2nd, 1955.

BOX No. E2289, "The Engineer." A

MANAGER, for modern factory turning out light engineering components for the trade, with batch production methods. Applicants must be under 45 years old, and be practical mechanical engineers with previous similar experience. First-class men only need apply for the vacancy, which carries a high salary with great opportunities.—BOX No. E5128, "The Engineer." A

MATERIAL HANDLING is a go-fast, but go-sure, technique. Engineers engaged in it have to be trained and rapid thinkers. That is why Ford Motor Company, Limited, of Dagenham, Essex, want go-ahead men with at least O.N.C.

Have you a flair for large volume handling? If so, we are interested. Your starting salary will be commensurate with your experience and qualifications. Your future is secured by an excellent non-contributory pension.

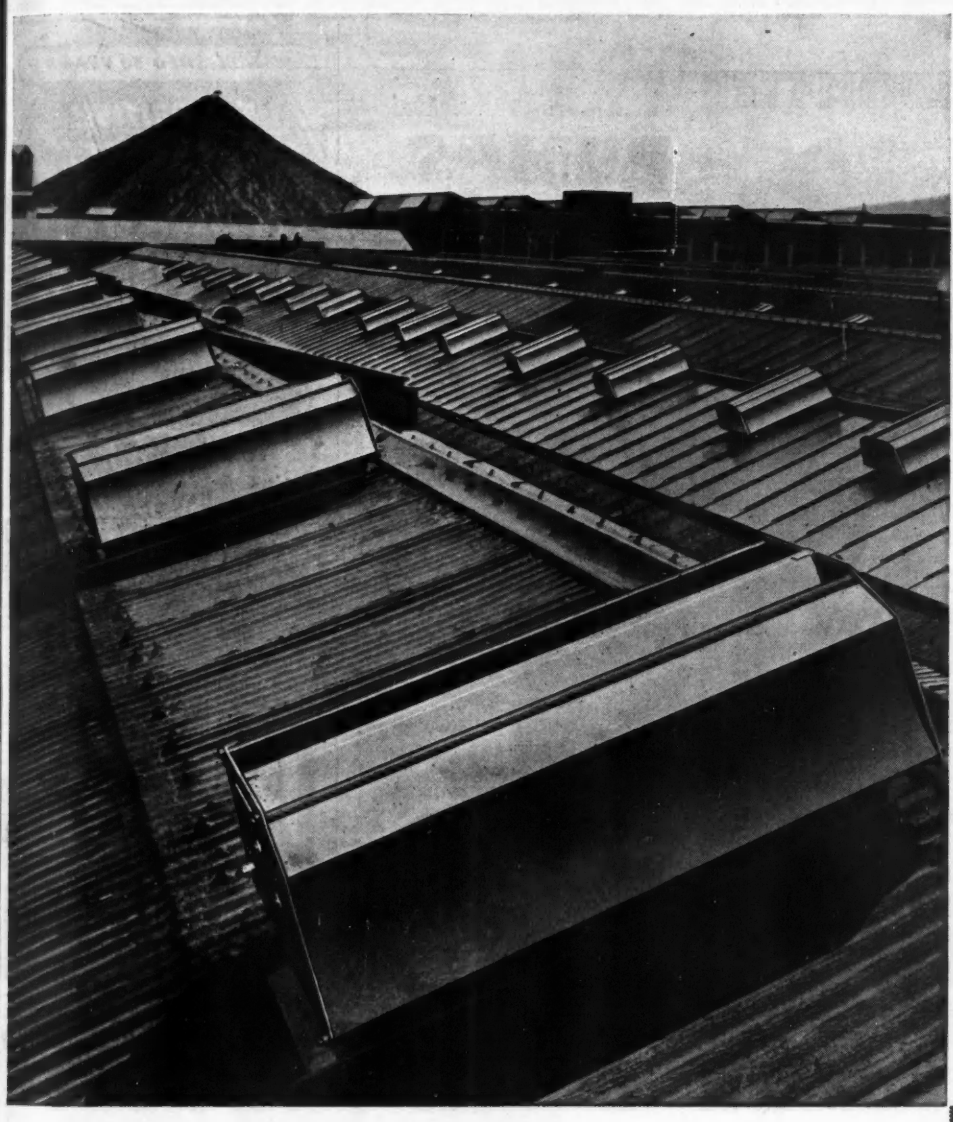
There is no time like the present for joining us. Our vast expansion will give you ample scope to prove your worth. Our Salaried Personnel Department will be glad to hear from you. Please quote KMH/3. E5383 A

MECHANICAL ENGINEER.—A young man, age 25/30, is required to train as assistant to director in charge of a large fleet of mechanical equipment. The person appointed will eventually be expected to take over a managerial position in the company. It will be an advantage if he has served an apprenticeship and in R.E.M.E. A knowledge of electrical equipment is also desirable. Applicants must submit brief particulars of their education and training.—BOX No. E5259, "The Engineer." A

MECHANICAL ENGINEERING DRAUGHTSMAN required for industrial refrigeration engineers. Position gives ample scope for man with mechanical design ability. Permanent staff, progressive position.—Alfred Porter and Co., Ltd., Stella Works, Stanley Road, Teddington, Middx. E2306 A

Classified Advertisements are continued on page 134

Critical temperature control and ventilation . . .



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Dunlop Rubber Company

at their Dunlopillo factory at Hirwaun

Having consistently used Colt Equipment since the early days of the war, Dunlop's consulted Colt.

A detailed survey proved that the requirements could be fulfilled by the installation of a fully controllable ventilation system of natural roof extraction by Colt SRC 2046 Controllable High Duty Roof Extractor Ventilators with air inlet by Colt Mechanical Inflow Units.

The Client's satisfaction is proved by the fact that Colt Equipment has since been specified for a further large contract at Hirwaun.

FREE MANUAL with full specifications of the wide range of Colt Ventilators is available on request from Dept. G20/188.

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We have recently reprinted and completely revised our stop watch and chronograph catalogue. It contains, in addition to our comprehensive range of stop watches and chronographs, a paper, "Some notes on stop watches," which is of interest to all users of stop watches and chronographs.

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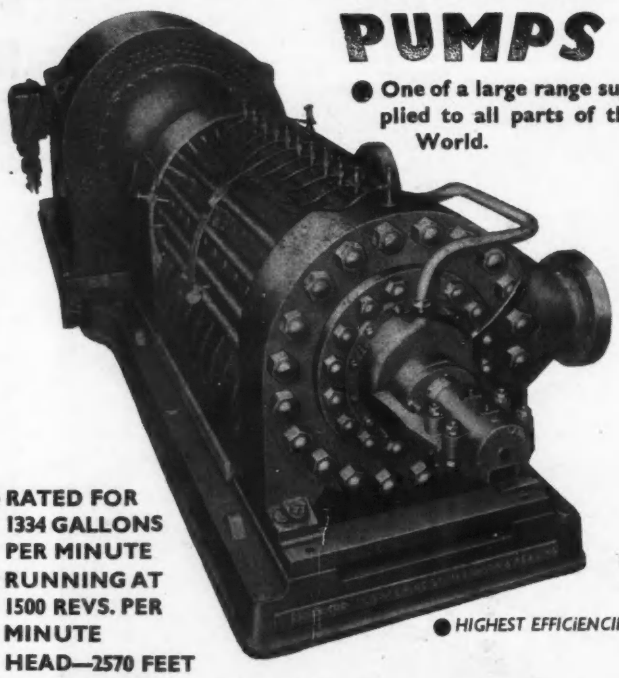

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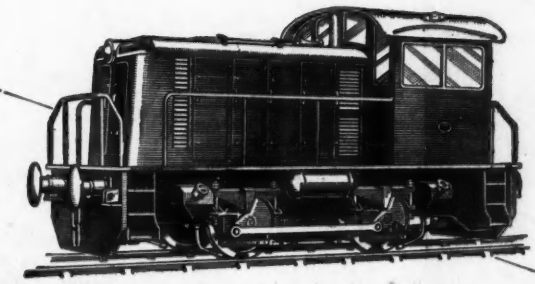

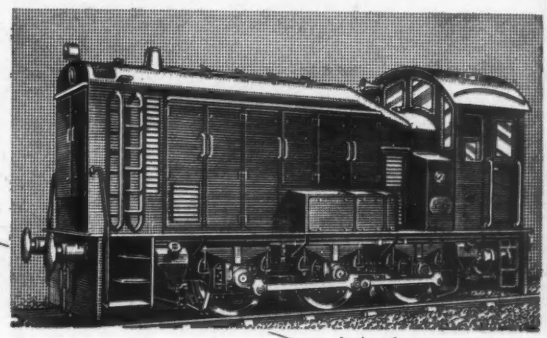

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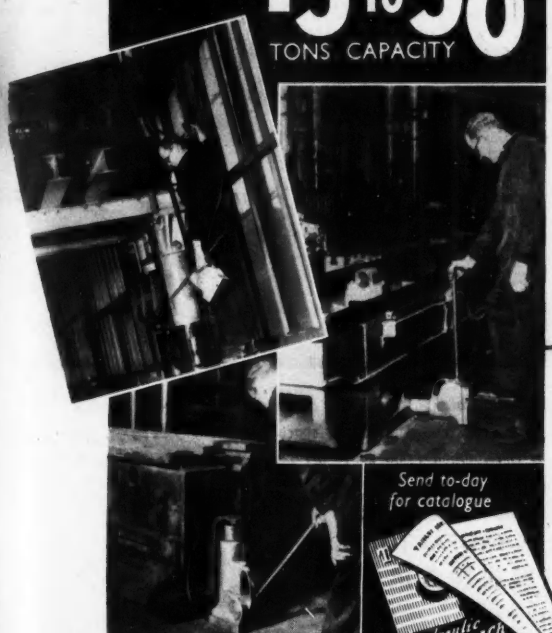

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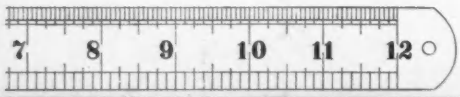

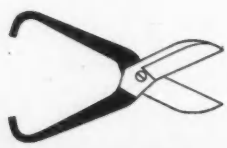

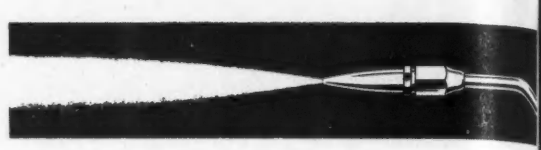

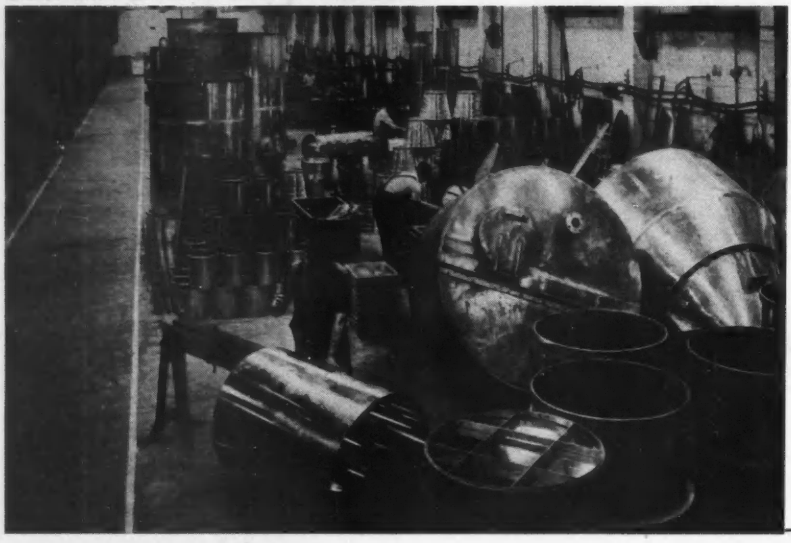

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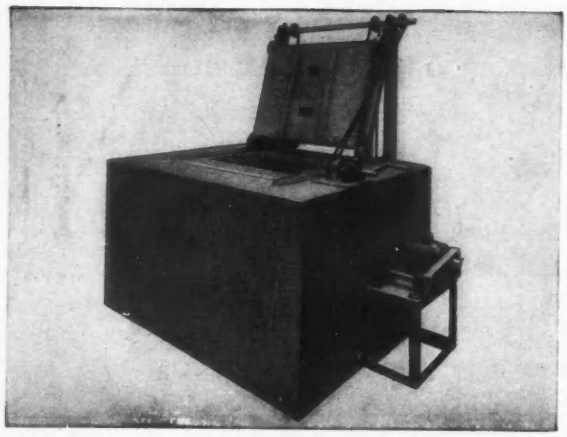

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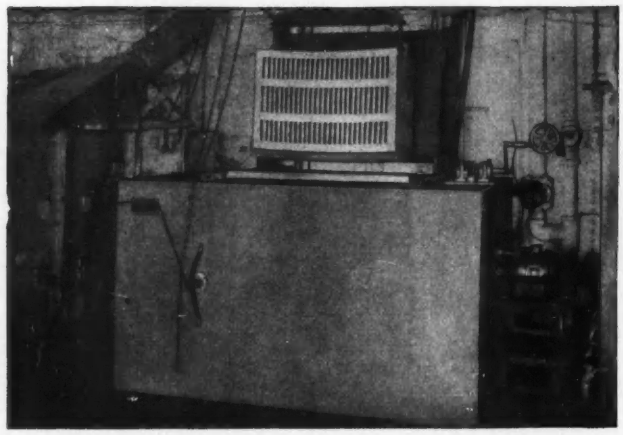

This photograph illustrates the furnace in operation with heat resisting steel workbasket being extracted. The working space is 3 ft. long × 2 ft. × 2 ft. deep and gas consumption 1,000 cu. ft. per hour with average 700 cu. ft.

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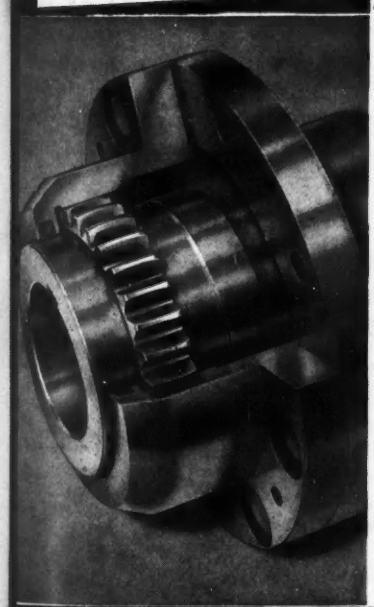

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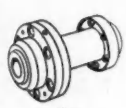
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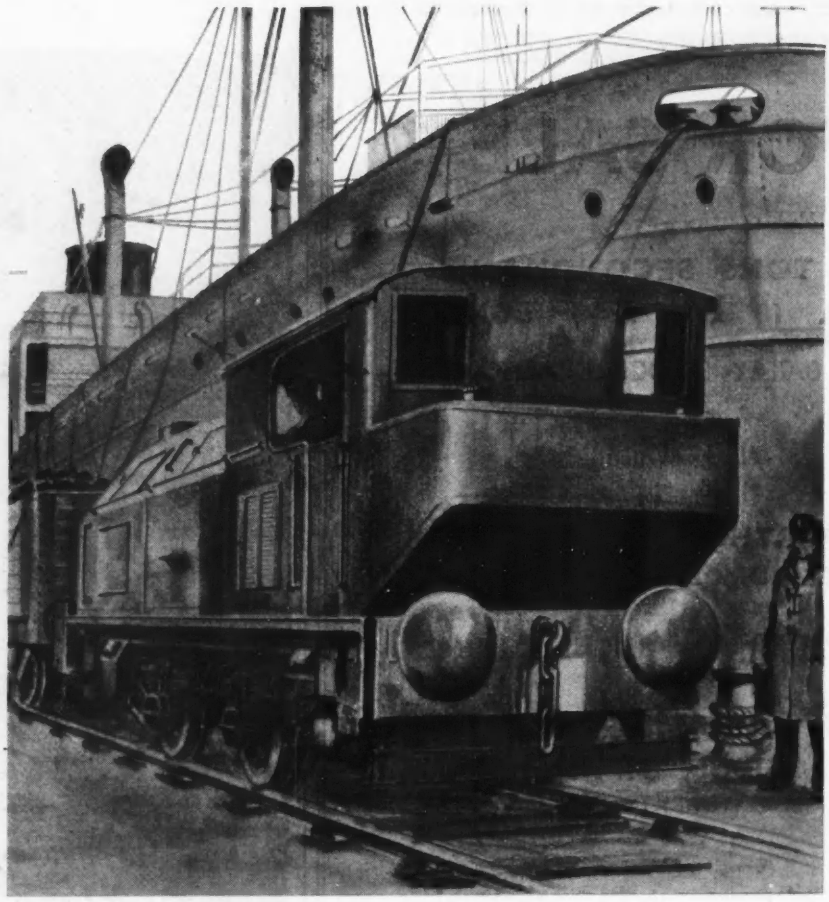

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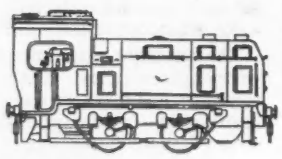

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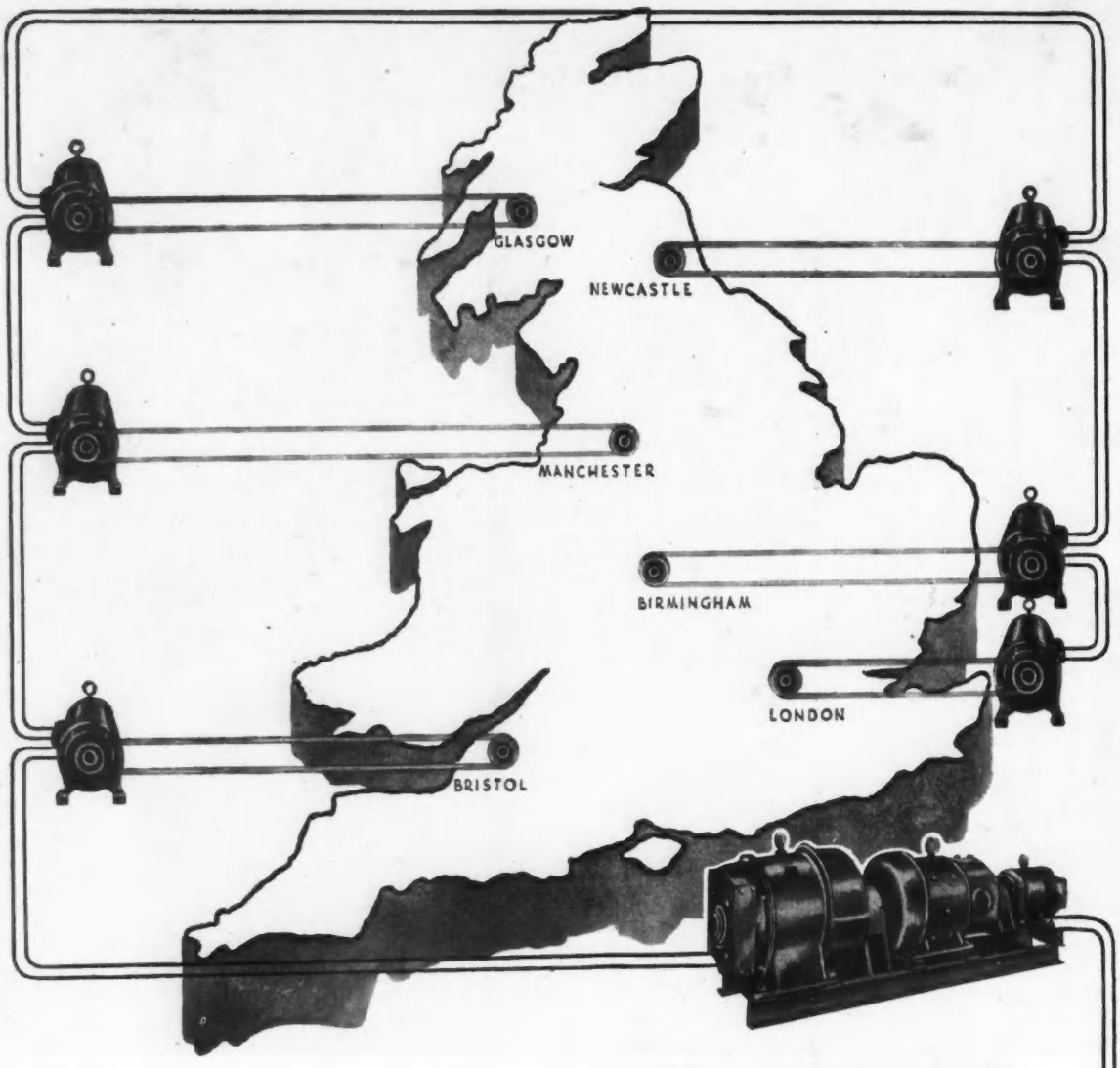

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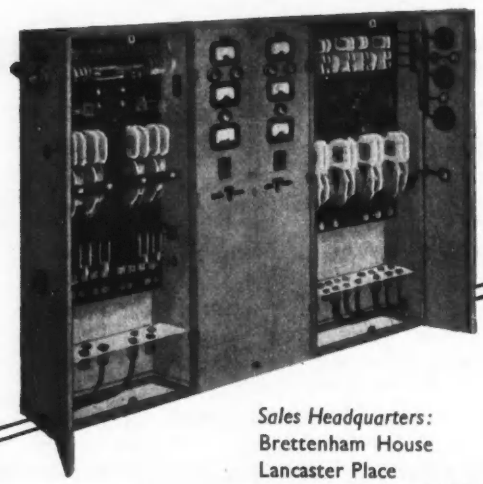

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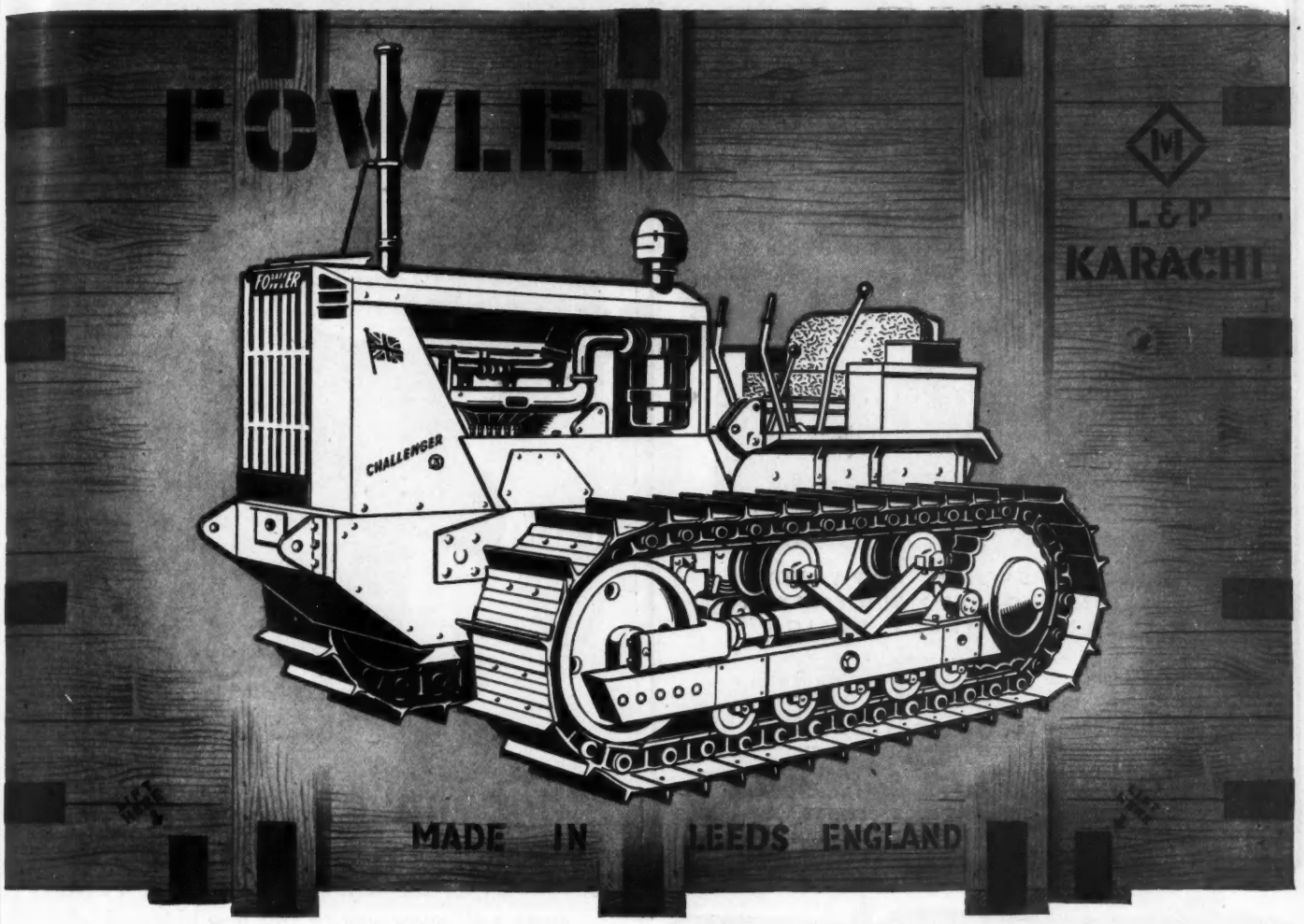

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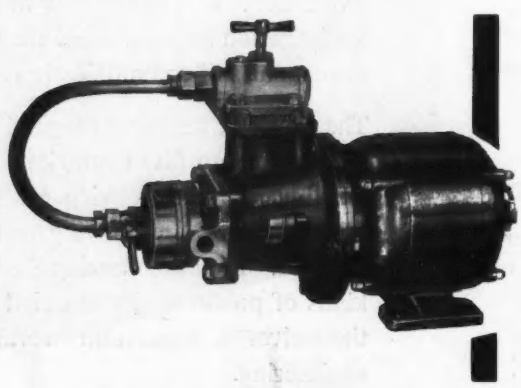

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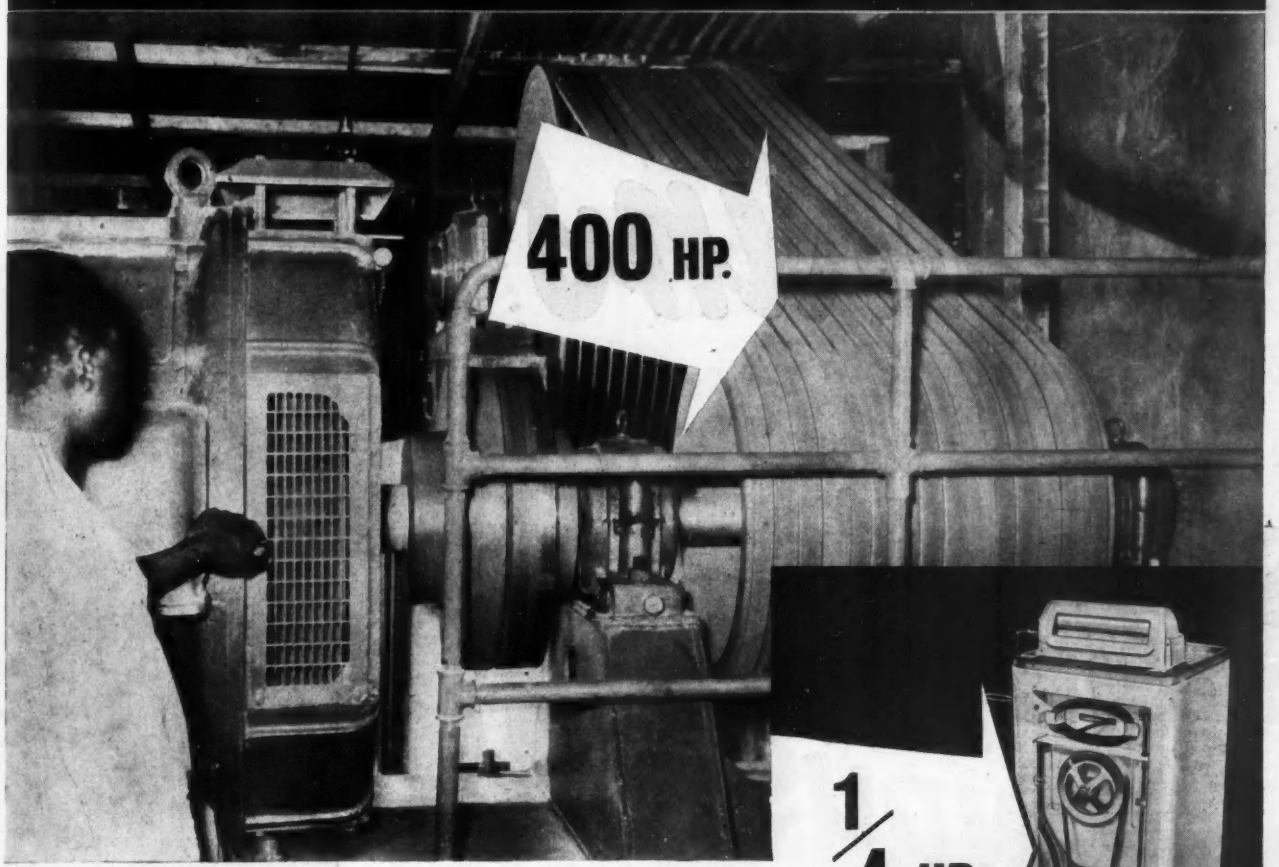

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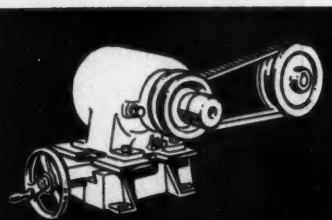

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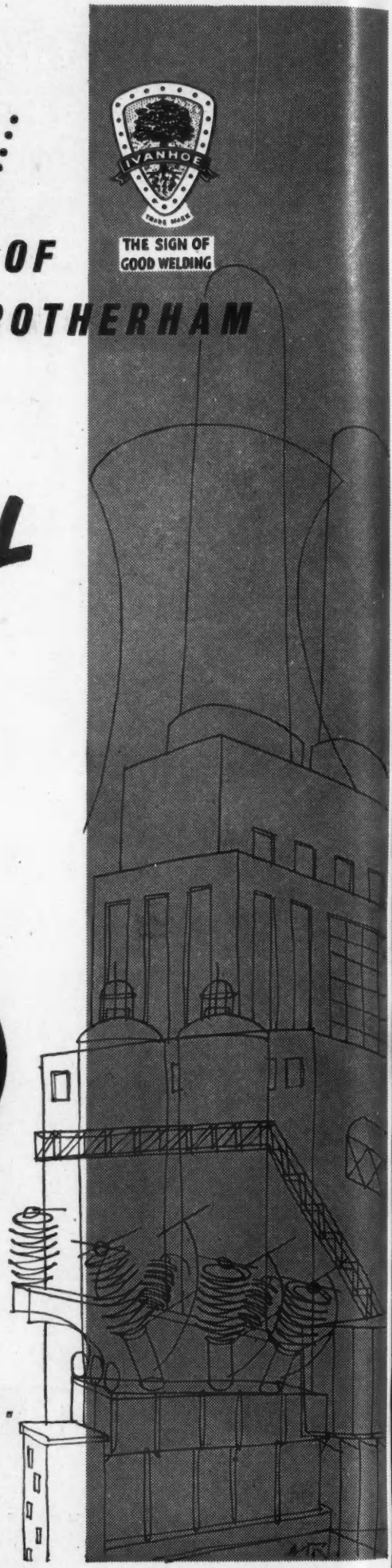

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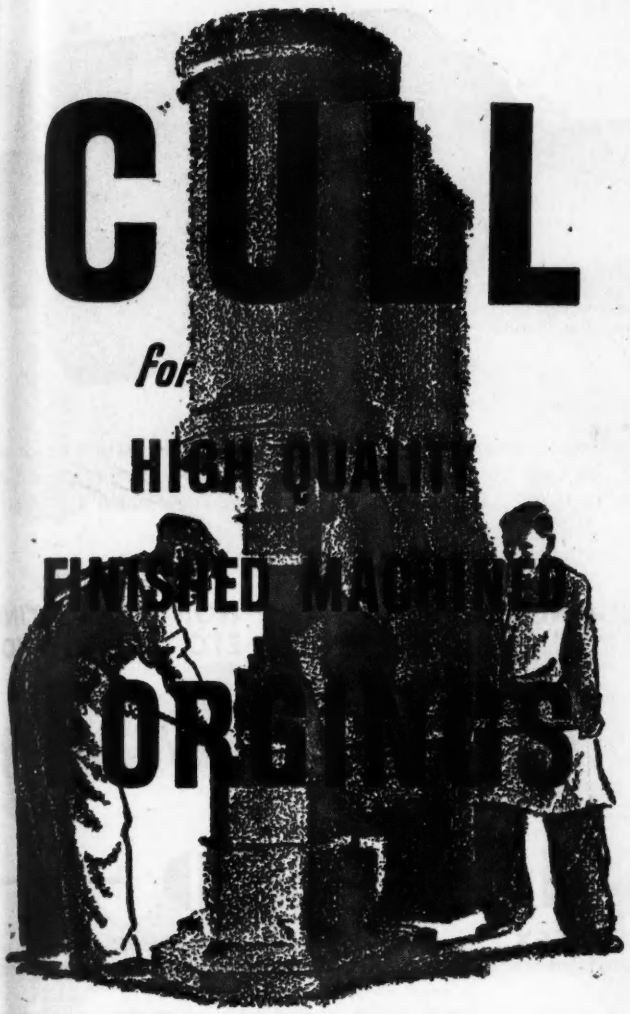

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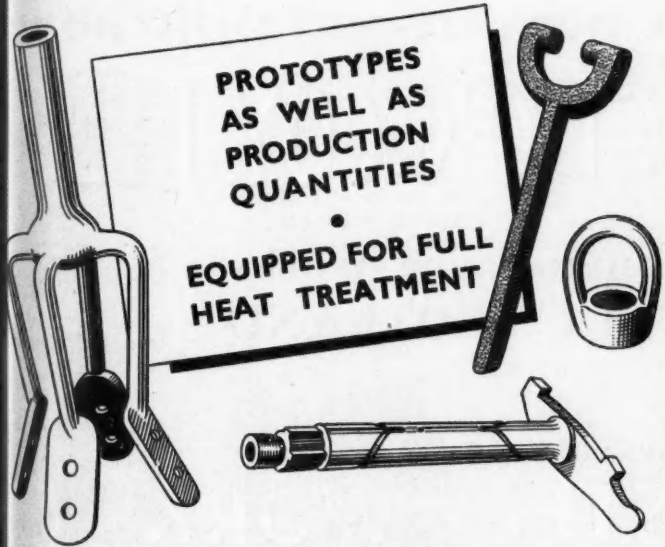

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BANBURY MIXERS

For Quality Automatic Mixings and High Production

FOR MIXING AND MASTICATING
RUBBER natural & synthetic
PLASTICS
LINOLEUM
PAINTS & ASPHALT

Sizes and Capacities of Standard Bridge-Banbury Mixers

Size of Machine	Net Volume of Chamber		Approx. Batch Size in lb. Spec. Gravity × Factor	Motor H.p.	Speed	Length	Floor Length	Space Width	Width
	cu. in.	c.c.			r.p.m.	ft. ins.	mm.	ft. in.	mm.
B	103	1,690	Sp. G. × 2·5	7½	710	5 0	1,524	4 0	1,218
00	263	4,310	Sp. G. × 4	10	485	8 0	2,436	4 0	1,218
1	1,140	18,700	Sp. G. × 24	40	485	13 6	4,114	7 6	2,286
3A	4,562	74,750	Sp. G. × 100	100	485	15 0	4,572	8 0	2,436
9	11,443	187,500	Sp. G. × 225	200	485	33 0	10,100	9 6	2,895
11	15,469	253,500	Sp. G. × 300	250	485	27 0	8,228	11 0	3,352

Approx. 4 to 8 BATCHES PER HOUR ON RUBBER AND PLASTIC STOCKS on standard speed machines.

By arrangement with Farrel-Birmingham Co. Inc., Ansonia, Conn., U.S.A. We are the sole makers and licensees for Great Britain, Europe generally, and the British Commonwealth and British Overseas Territories (except Canada) for Banbury Mixers.

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these remarkable couplings are now used all over the world—made in five series :-

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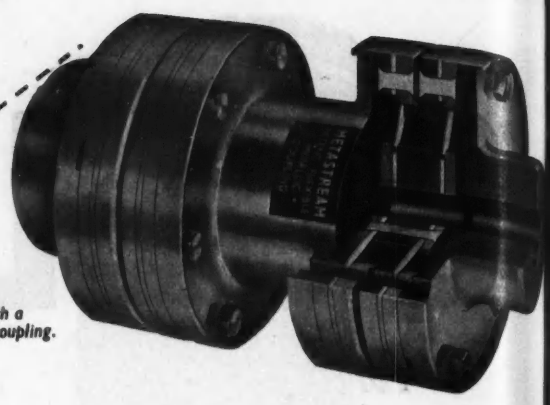
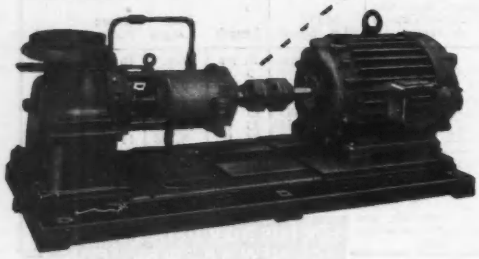


Section through a spacer type coupling.

4. 'H.S.' Metastream high speed couplings individually designed for gas turbine drives etc., duties up to 10,000 h.p. at 30,000 r.p.m.
5. 'S.B.' types for single bearing motor and generator drives. Flywheel adaptors available for engine driven units.



Photograph shows a process pump, manufactured by Messrs. Hayward-Tyler & Co. Ltd. fitted with a spacer type Metastream flexible metallic coupling.

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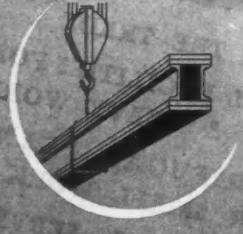

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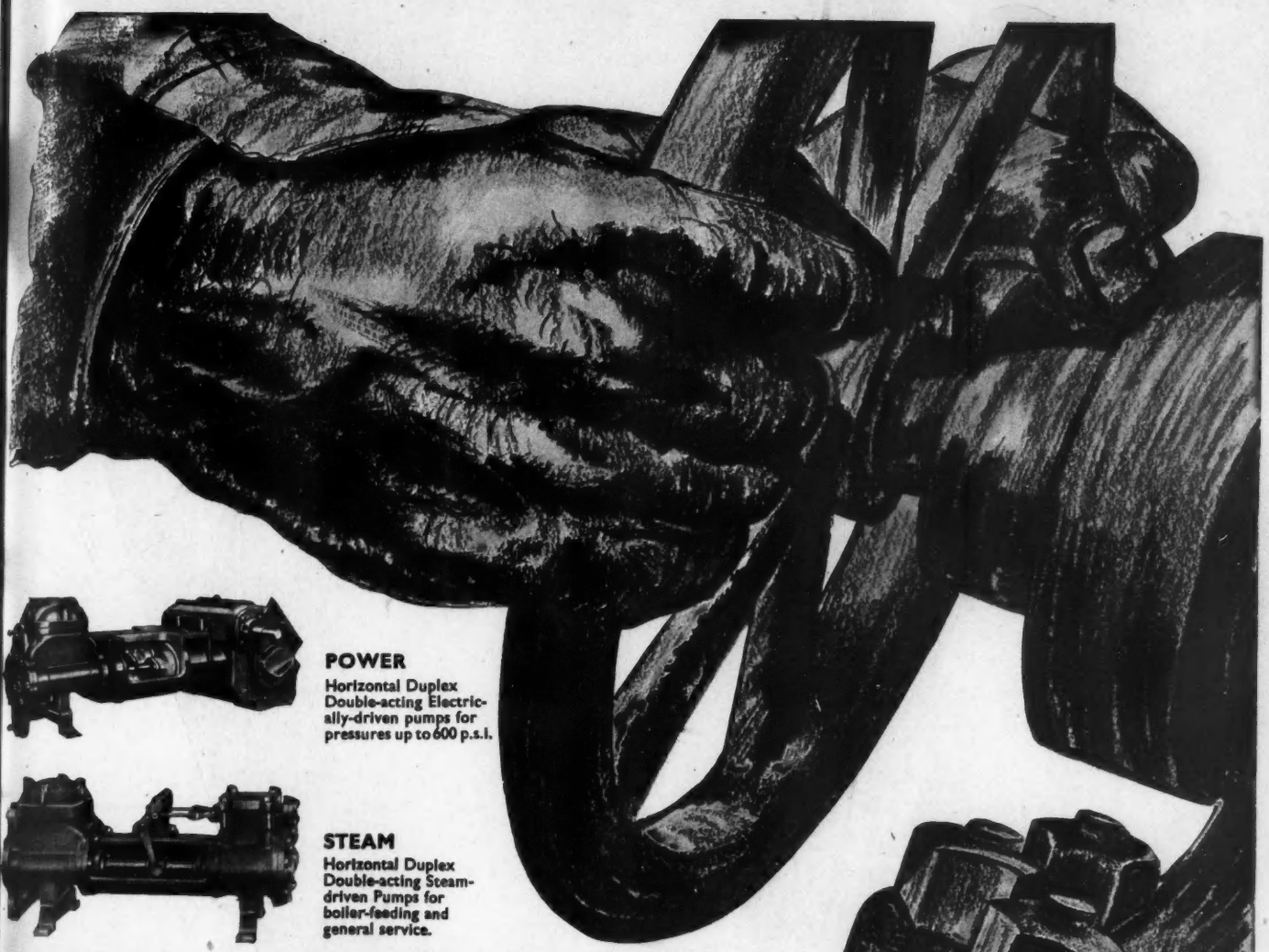

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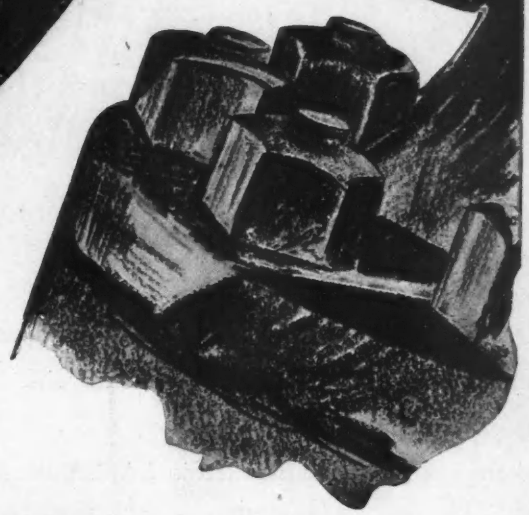

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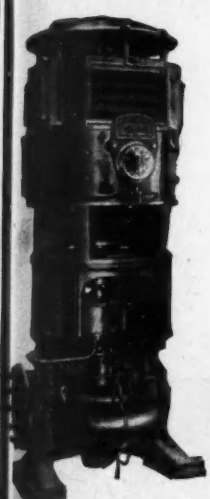

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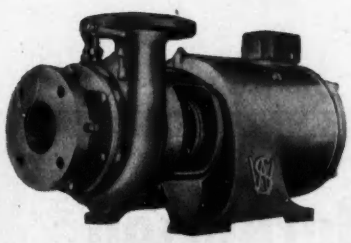

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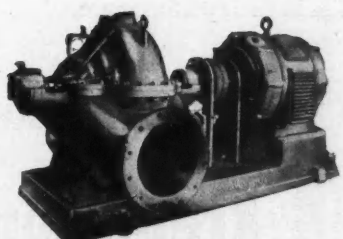

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P.4610

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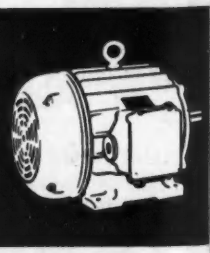

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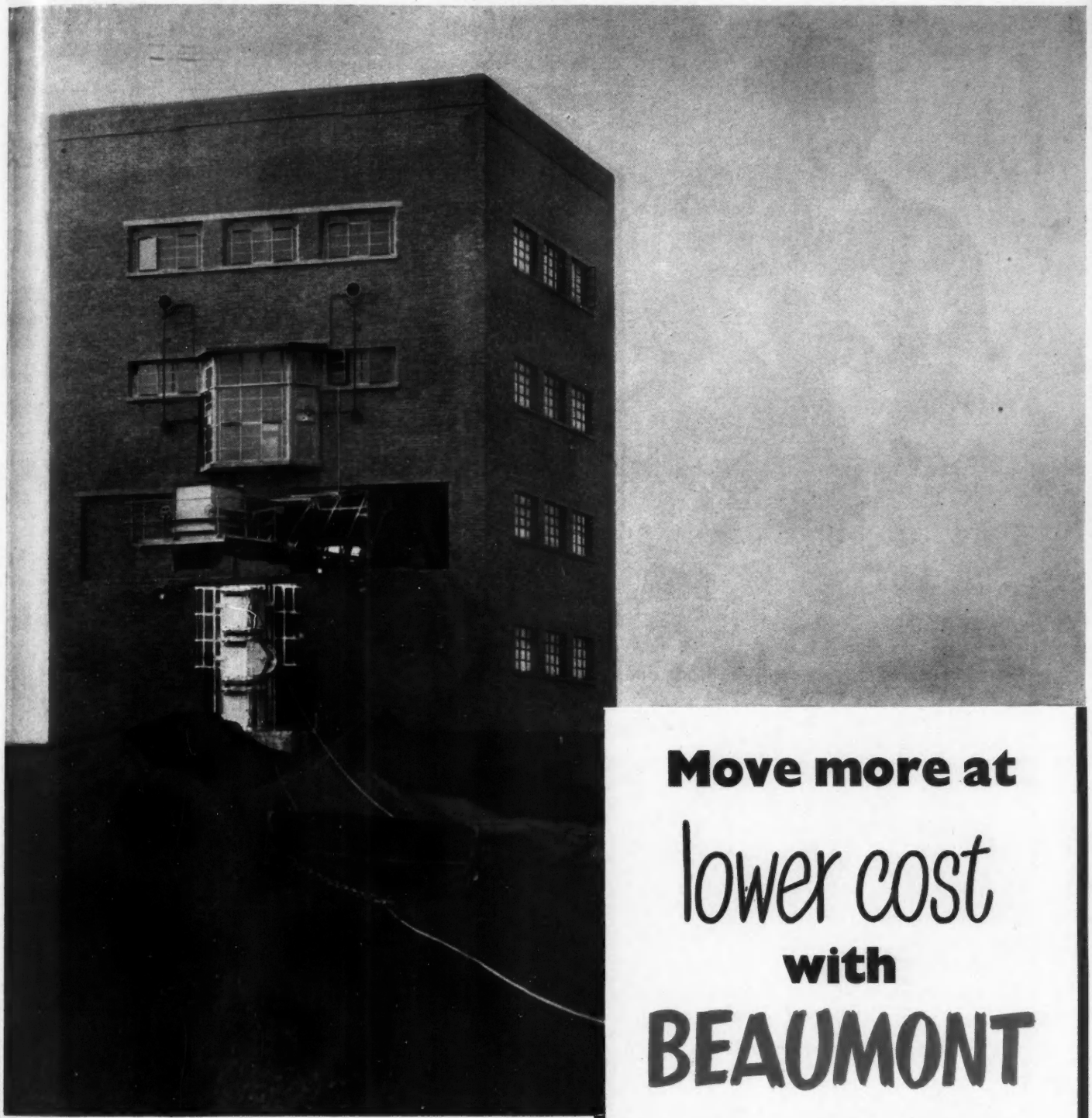

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D

INSIDE STORY

"Got my Drayton-Armstrong Book to-day, Chief."

"*So what, Son.*"

"I can't quite see how the free-floating lever arrangement works."

"*Never mind, Son.*"

"How d'you mean, never mind? Doesn't it matter?"

"*'Tisn't how it works that matters, my lad. It's what it does that's important.*"

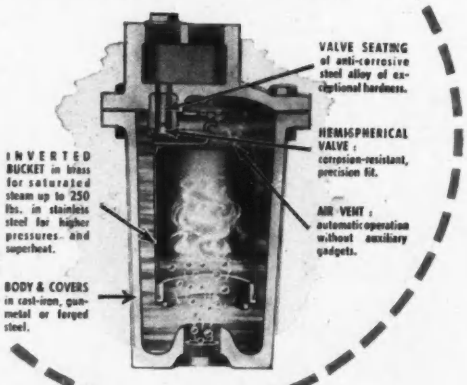
"What does it do, Chief?"

"*Gives the trap the highest capacity and longest life of any trap there is, my lad.*"

The unique free-floating lever system is almost completely frictionless; there is nothing to clog, stick, bind or collapse. This, combined with the high material and manufacturing specification, makes the Drayton-Armstrong virtually trouble-free.

High leverage gives the Drayton-Armstrong bigger discharge capacity: size for size it can handle MORE condensate. The Drayton - Armstrong gives a trapping performance *over the whole of its long life* which cannot be bettered by any other system.

Inside Story of the Drayton-Armstrong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(The Drayton-Armstrong Book on trapping explains all this and is well worth writing for)

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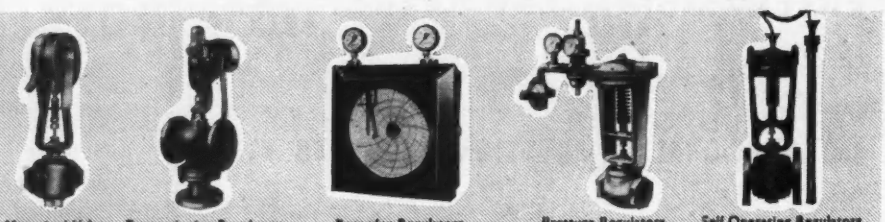

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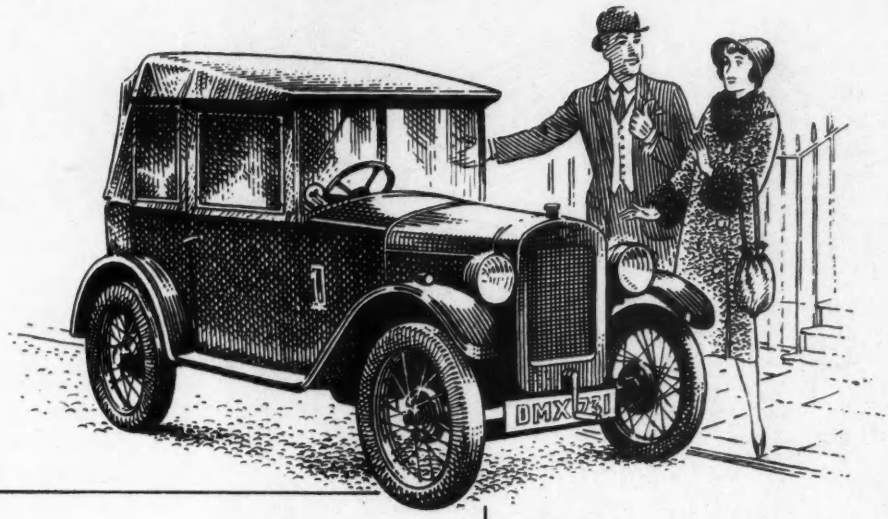
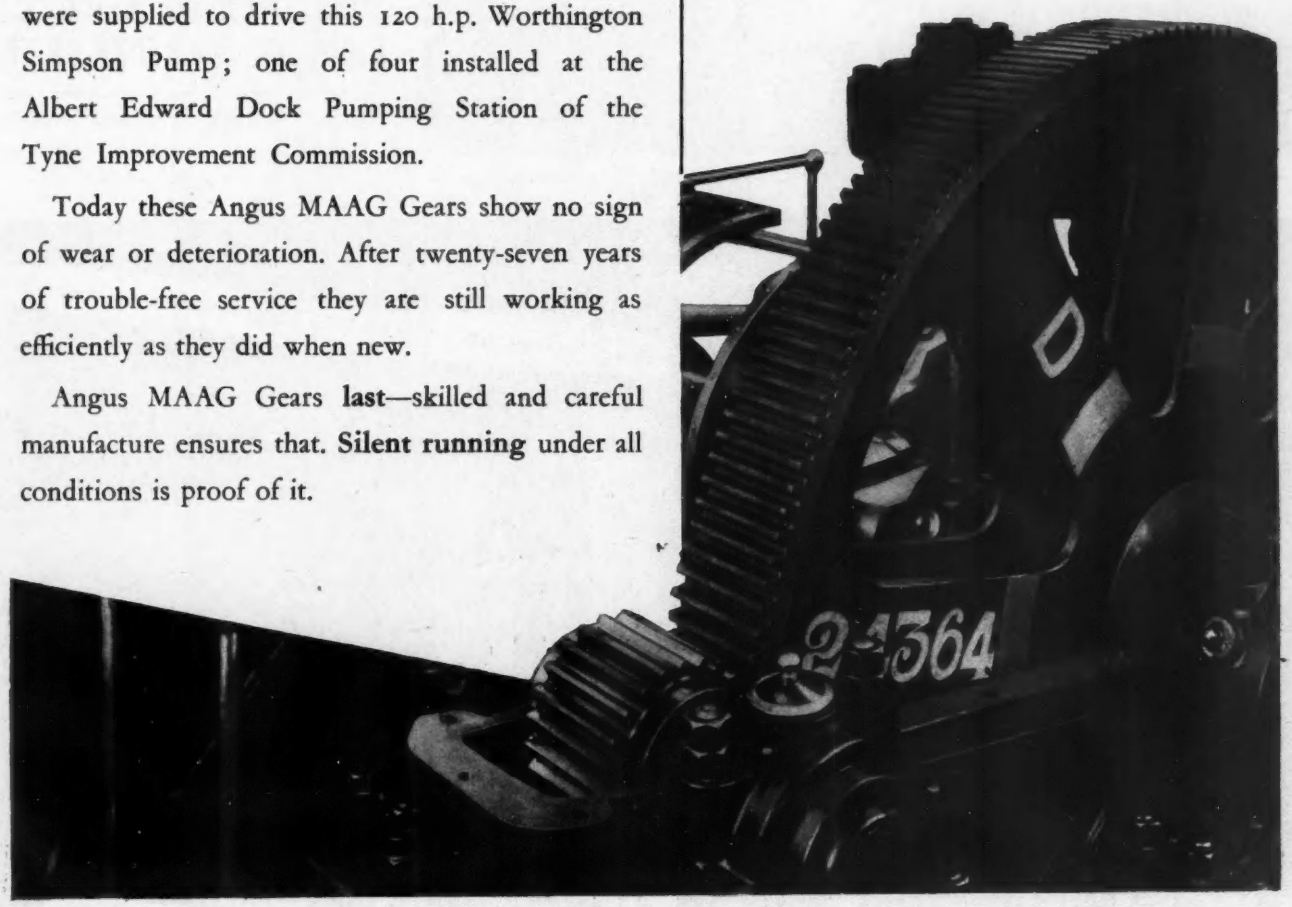


When your '28 Car was Delivered..

—just twenty-seven years ago—Angus MAAG Gears were supplied to drive this 120 h.p. Worthington Simpson Pump; one of four installed at the Albert Edward Dock Pumping Station of the Tyne Improvement Commission.

Today these Angus MAAG Gears show no sign of wear or deterioration. After twenty-seven years of trouble-free service they are still working as efficiently as they did when new.

Angus MAAG Gears **last**—skilled and careful manufacture ensures that. **Silent running** under all conditions is proof of it.



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Angus Gear Division

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★ *One of four pumps equipped with Angus MAAG Gears, and installed in 1928 at the Albert Edward Dock Pumping Station of the Tyne Improvement Commission.*

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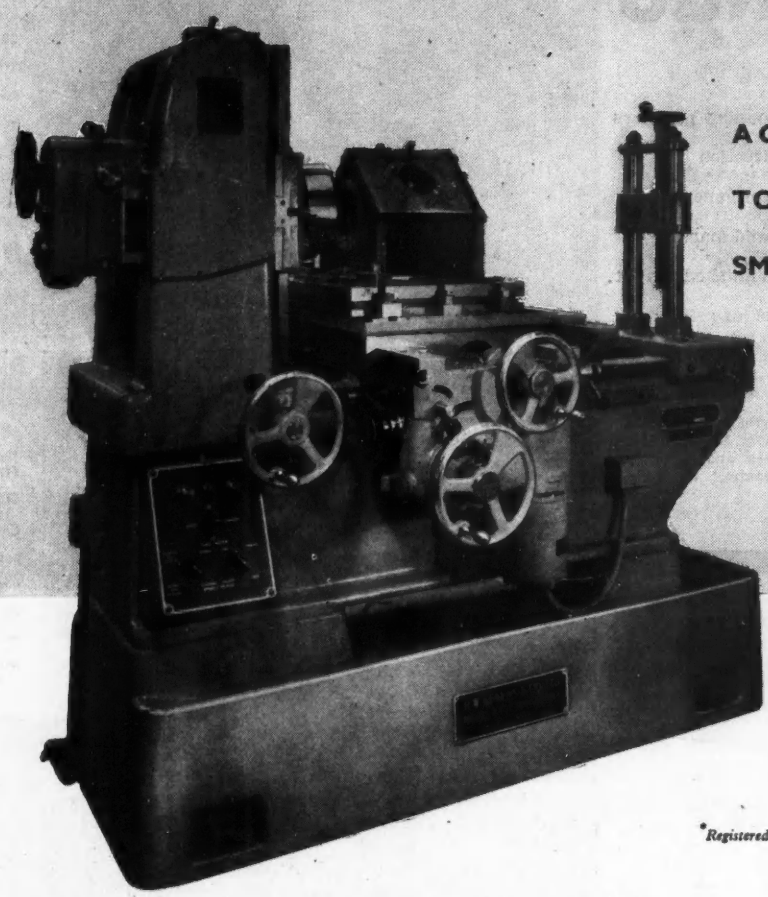

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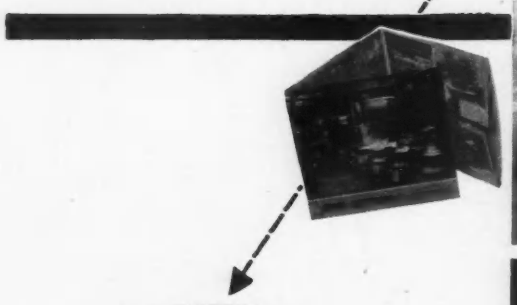

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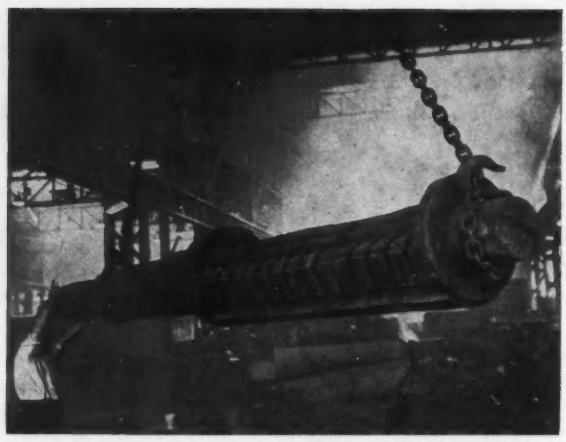
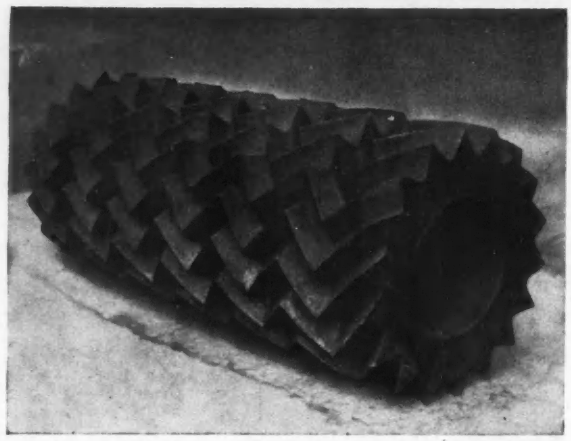


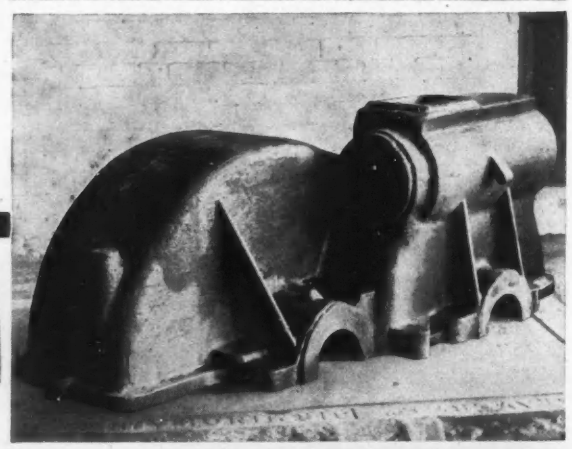
ALLOY CAST STEEL REEL SHAFT

19′ 0″ long. Due to the design these reel shafts have to be cast horizontally.



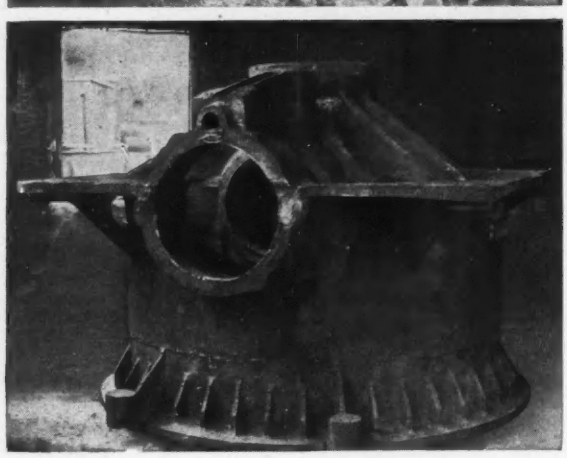
CRUSHER ROLLER SHELL

for sugar machinery. Weighing approximately 6¾ tons, the outside diameter is 37½″ with a length of 7′ 3″.



TOP HALF GEAR COVER

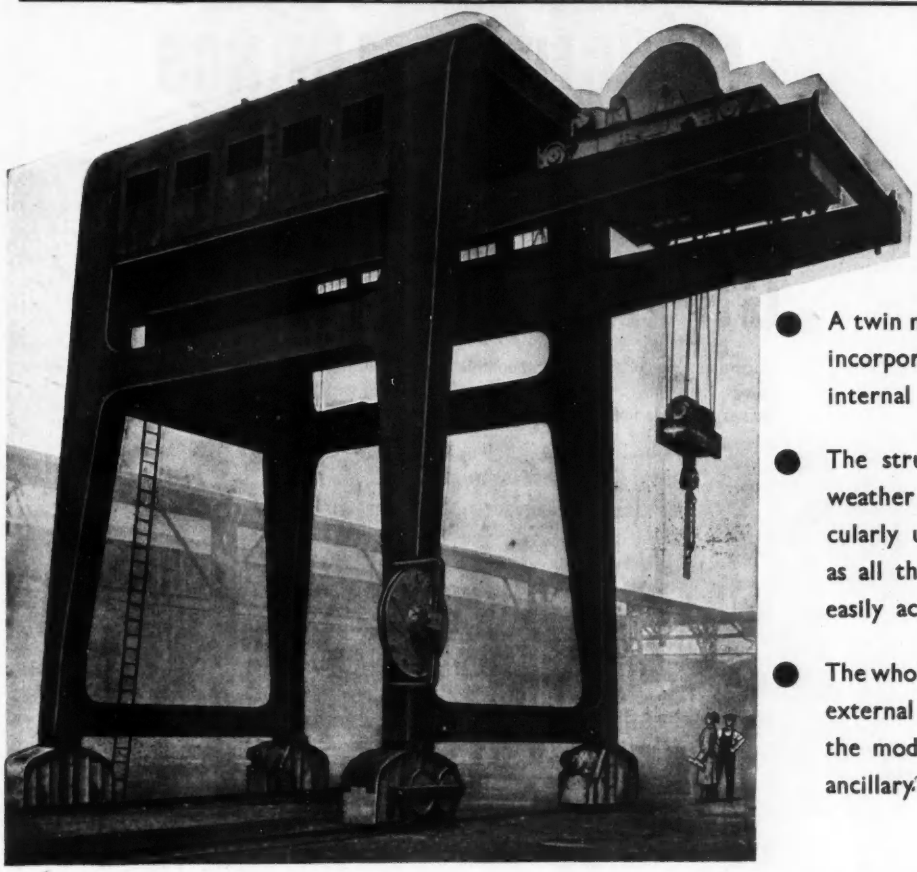
Certain sections of this casting must have a thickness of ¾″ to very close limits. To match the lower half, overall dimensions must be maintained.



MAIN FRAME FOR CRUSHING MACHINERY

This casting weighs approximately 11 tons.

GOLIATH *TRAVELLING GANTRY CRANE*



- The structure is of all-welded box plate construction throughout. This gives an exceptionally strong rigid frame.
- A twin motor travel drive is fitted which incorporates compensating bogies and internal expanding brakes.
- The structural lay-out gives complete weather protection to the crab ; particularly useful for maintenance purposes as all the components on the crab are easily accessible.
- The whole design gives a unique, pleasing external appearance in harmony with the modern design of the Dam and its ancillary buildings.

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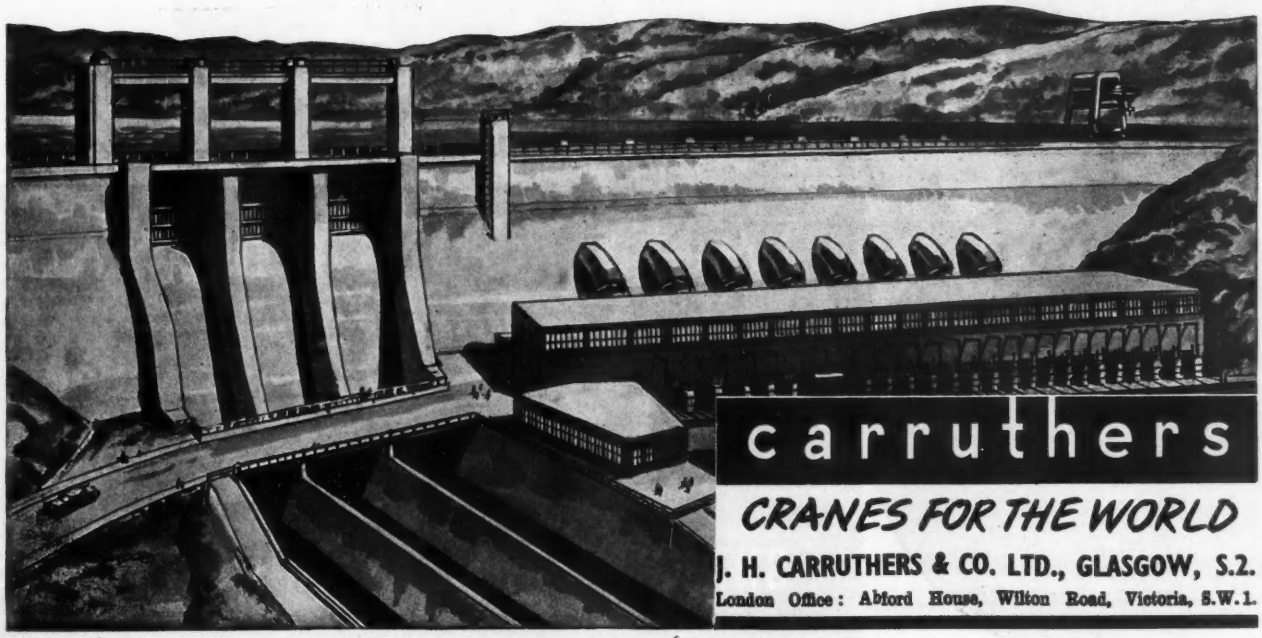
This 30 ton Goliath Travelling Gantry Crane is installed on the Dam of the Roxburgh Power project. This project is approximately 100 miles from Port Chalmers on the South Island of New Zealand.



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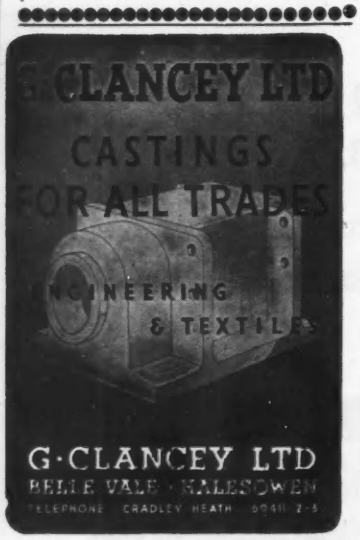

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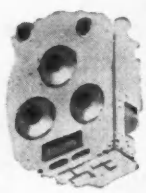

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Suitable for monolithic construction. For burner ports, crucible furnace linings and all positions where very high operating temperatures are encountered.

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Air-setting chrome-based ramming composition. Good attrition and slag resisting properties. For monolithic hearths in re-heating and forge furnaces, soaking pits and coating studded tubes in boiler furnaces, etc.

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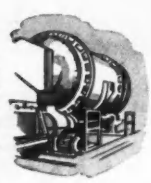

These are just a few of the extensive range of G.R. Refractory Compositions. Full particulars, technical advice and assistance in the selection and application of the most suitable composition are available on request.

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★ *Illustration shows Spinning Suction Nozzle 6ft. dia., 11in. deep, in ¼in. thickness aluminium*

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F

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SIZES
3" TO 10" OUTLET

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PER
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ELECTRIC MOTOR
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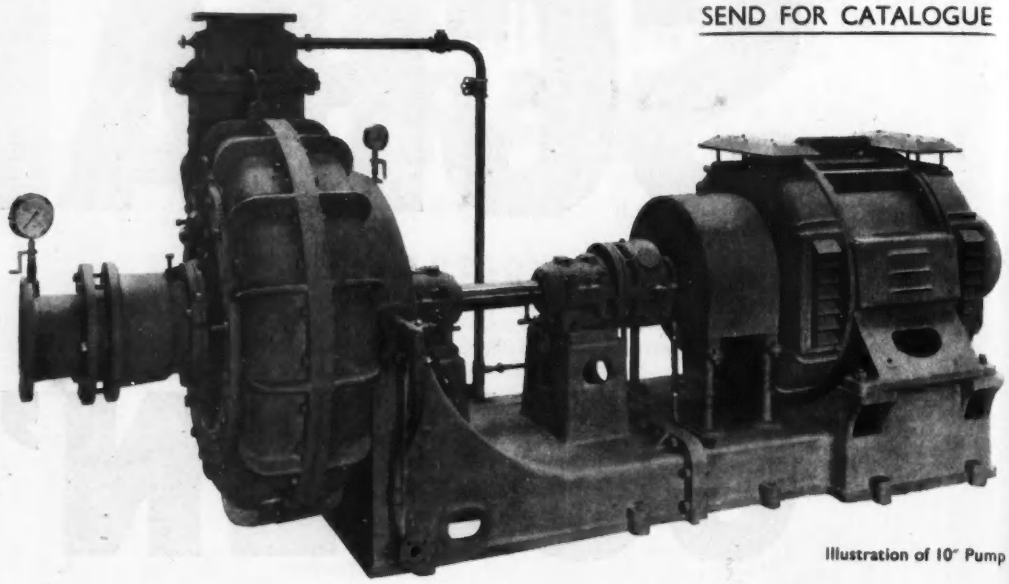
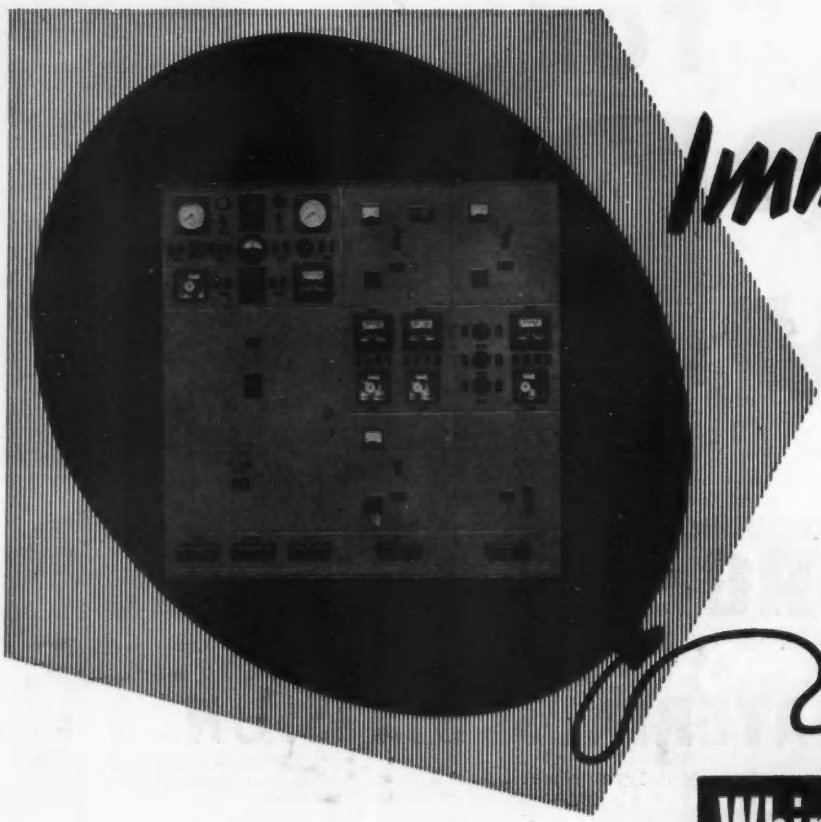


Illustration of 10" Pump

EASTON & JOHNSON LTD.

TAUNTON *ENGLAND* *Tel. 3146*



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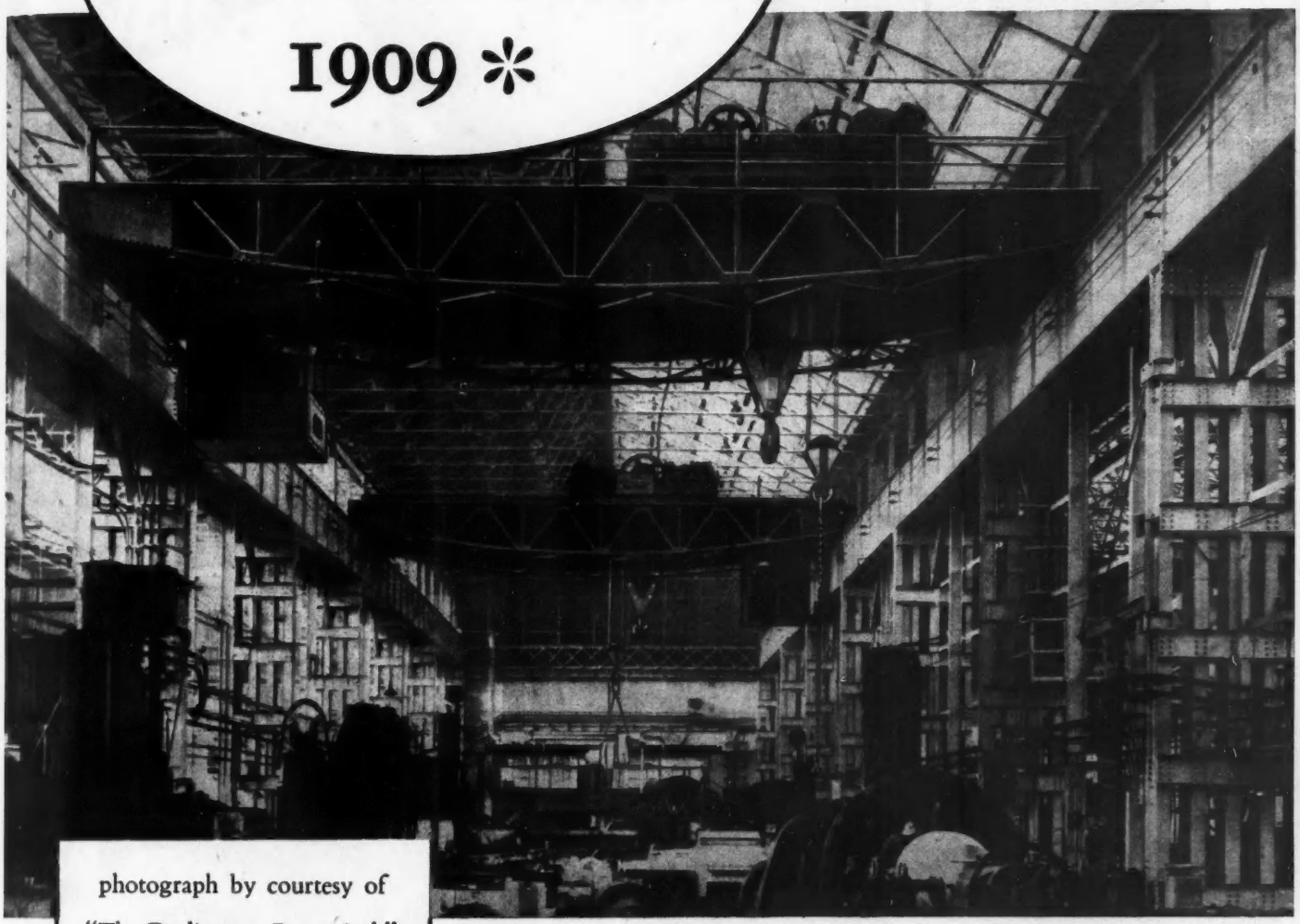
Trouble free service since 1909 *



photograph by courtesy of "The Darlington Forge Ltd."

* **For more than four decades the two cranes illustrated above have given trouble free service at The Darlington Forge Ltd. Each crane has a main hoist of 100 tons and an auxiliary hoist of 20 tons. They are still in first class condition and are capable of giving many more years of useful life.**

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JOSEPH BOOTH & BROS · UNION CRANE WORKS · RODLEY · LEEDS Telephone: Pudsey 3168 Telegrams: "Cranes, Rodley."

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FORGINGS • DROP FORGINGS • HARDENED STEEL ROLLS • HEAT TREATMENT

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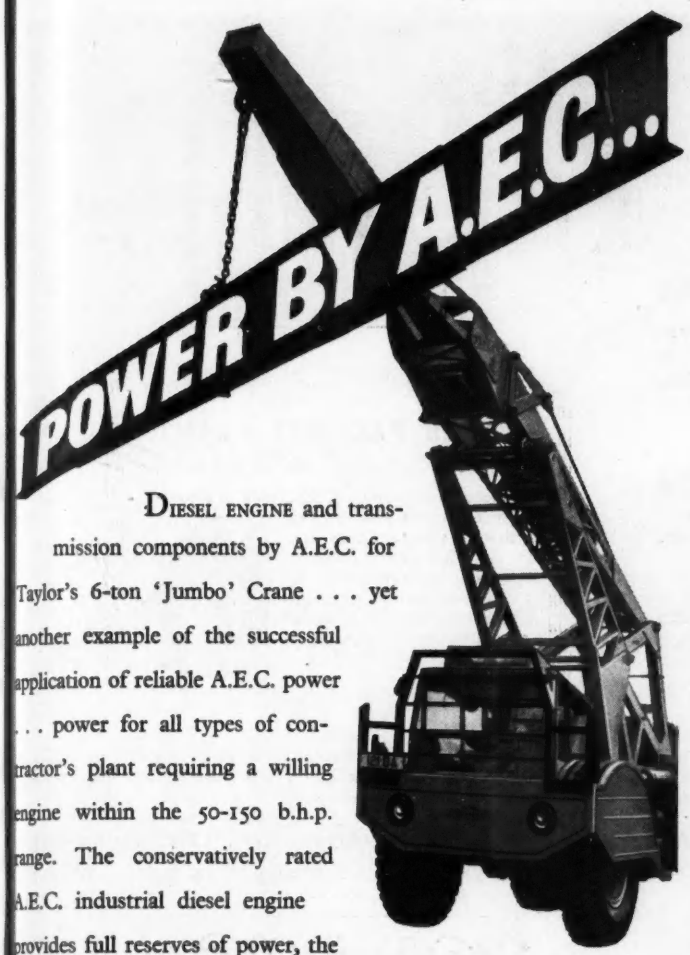
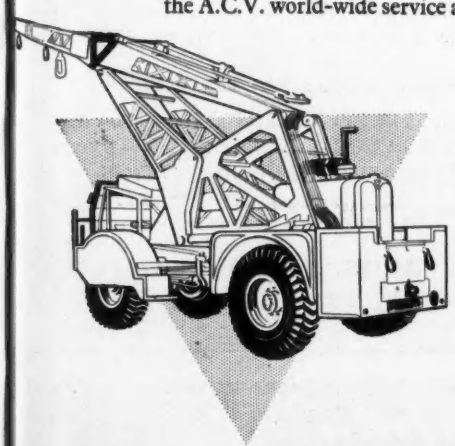


DIESEL ENGINE and transmission components by A.E.C. for Taylor's 6-ton 'Jumbo' Crane . . . yet another example of the successful application of reliable A.E.C. power . . . power for all types of contractor's plant requiring a willing engine within the 50-150 b.h.p. range. The conservatively rated A.E.C. industrial diesel engine provides full reserves of power, the heaviest work being handled with smooth celerity. And wherever A.E.C. powered plant is operated, it has behind it always the A.C.V. world-wide service and spares organisation.



'Jumbo' 6-ton hydraulic mobile crane, designed and built by F. Taylor & Sons (Manchester) Ltd., incorporates A.E.C. 7.7 litre industrial engine, A.E.C. gearboxes and driving axles.

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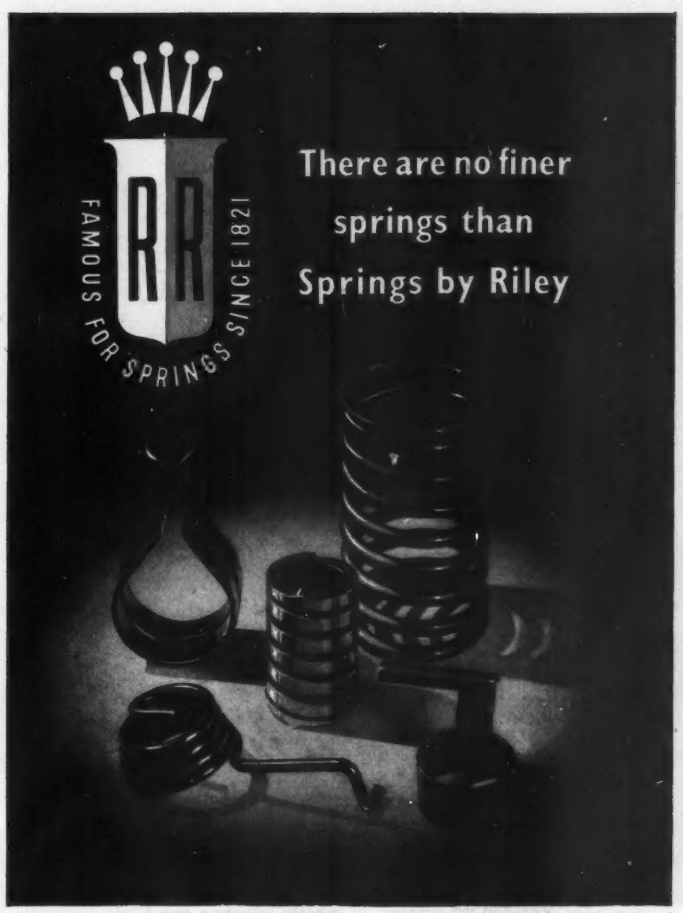
ONE OF THE BROCKHOUSE COMPANIES



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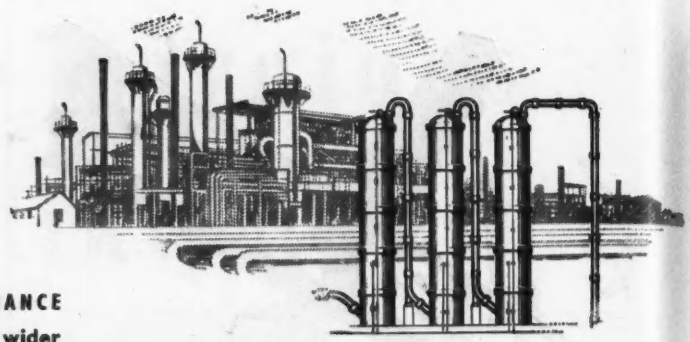
– the answer to corrosion



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Hathernware specialised design experience plus armouring of elements where required eliminates the usual risk of fracture. High compressive strength offers the maximum resistance to abrasion.

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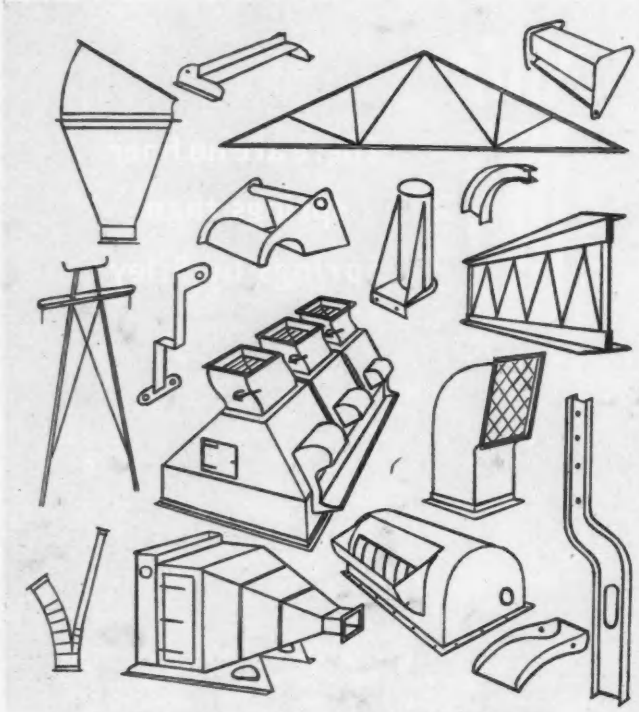

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Welded fabrication is mostly cheaper too!

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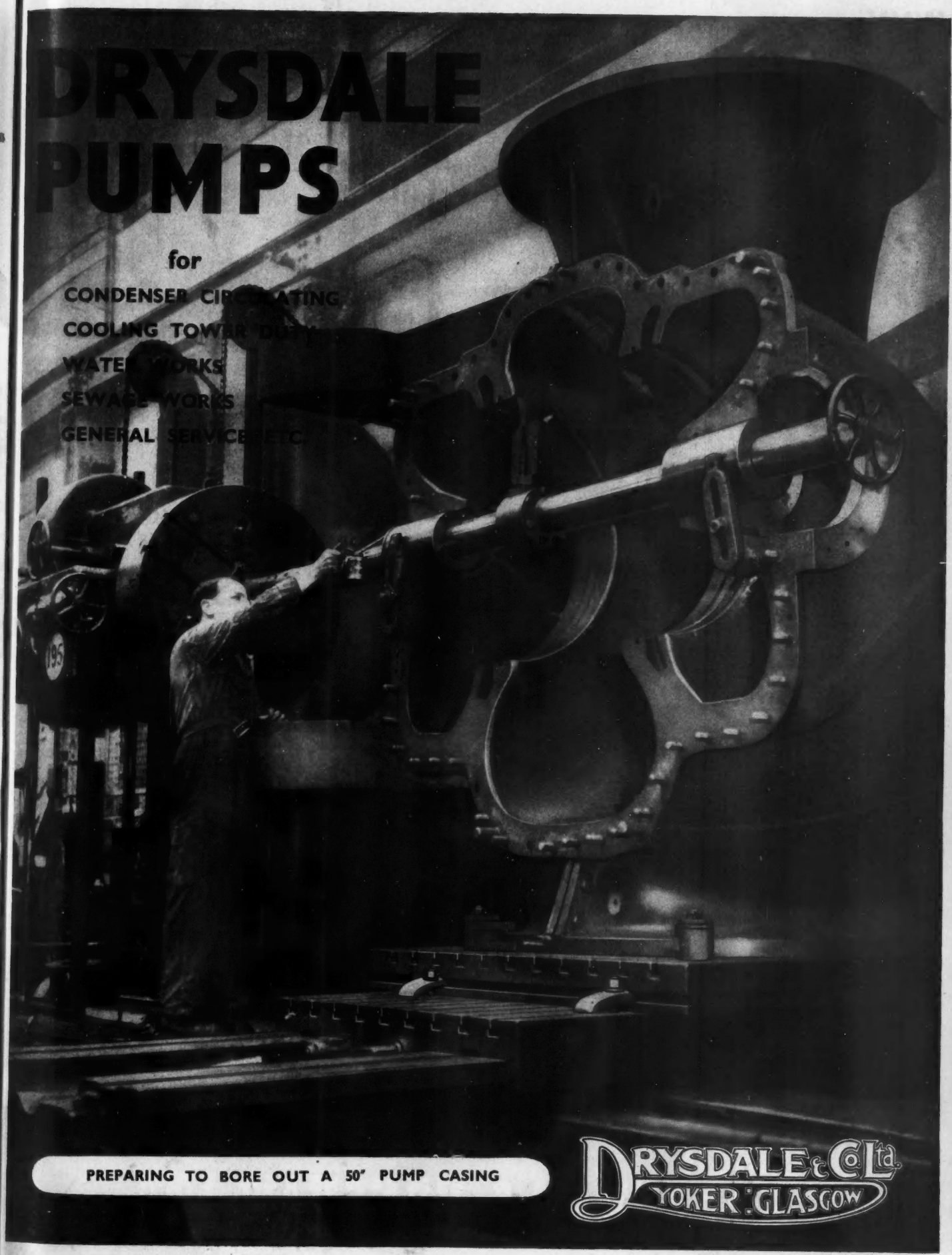
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MORE for LESS with TYPE HD GEARED MOTORS

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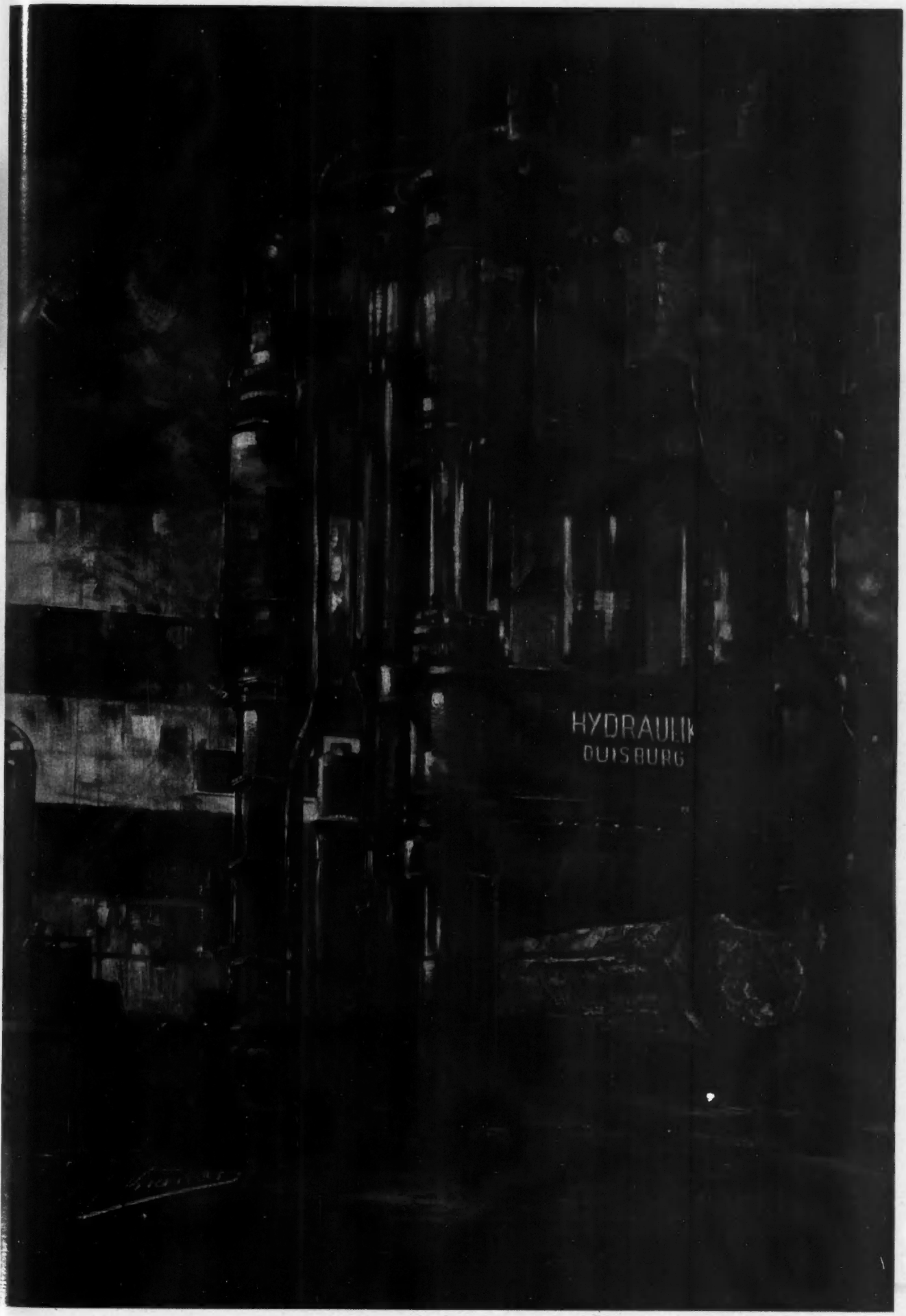
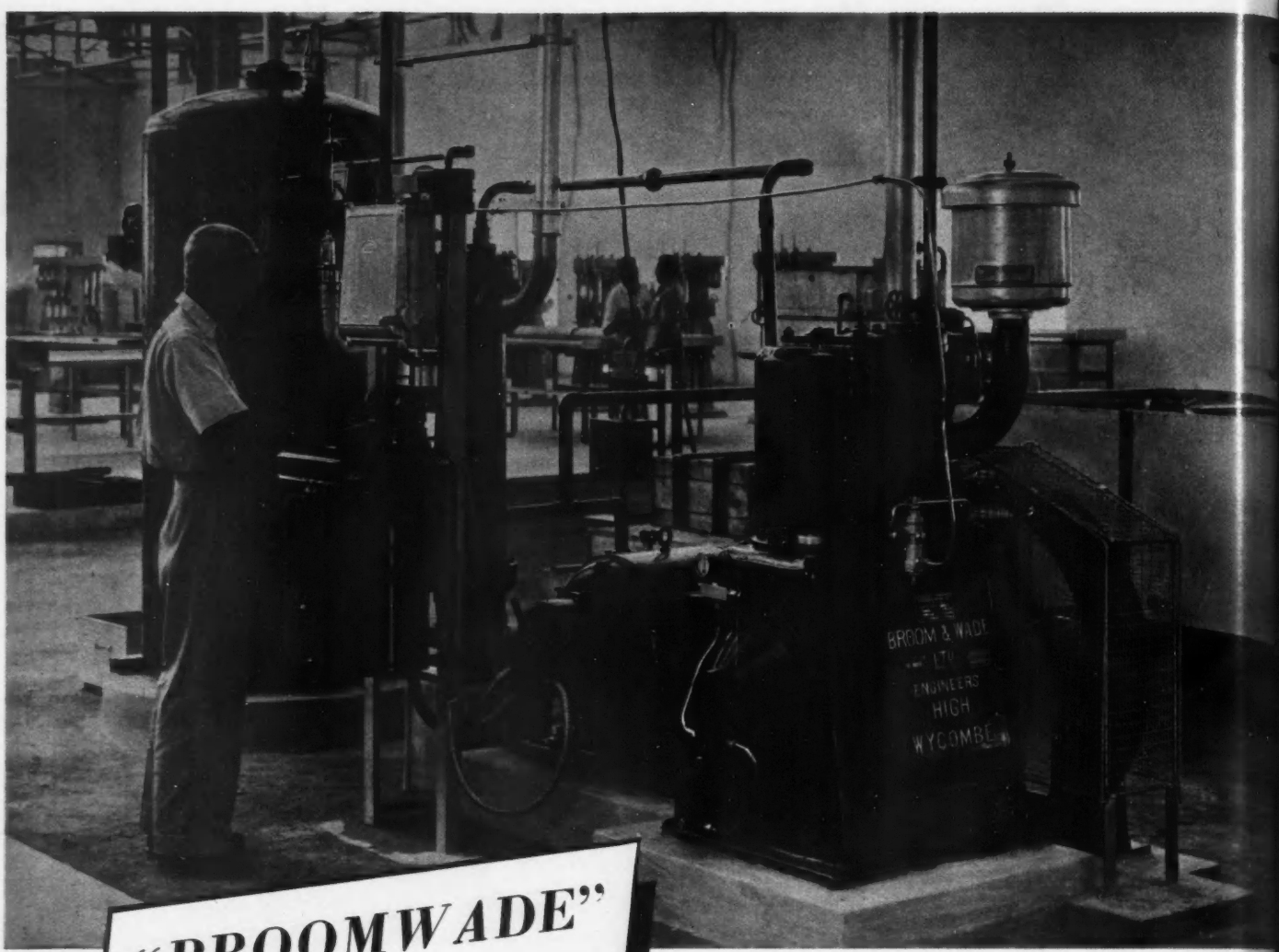


U.K. Agents, Aabacas Engineering Co. Ltd. Birkenhead, Cheshire.



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The "BROOMWADE" D type twin-cylinder compressor illustrated is installed at the Indian Telephone Industries works at Bangalore, supplying air for various duties. These machines have proved themselves during many years service in a number of countries. They are reliable in varying conditions.

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Aids every major industry

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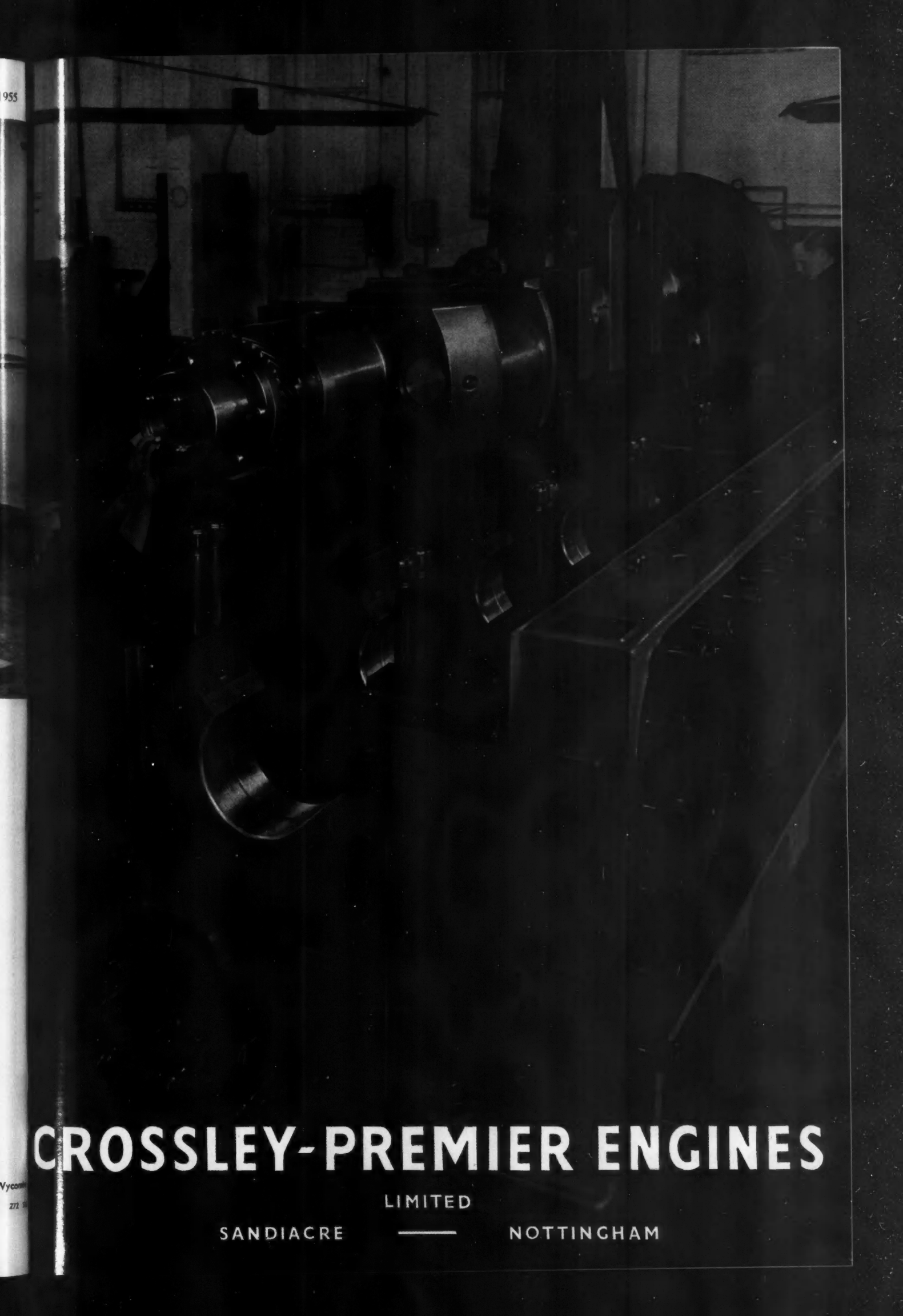
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MOLYBDENUM'S PLACE IN INDUSTRY

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Among others, the automobile industry plans a vast increase in production, but the supply problem is not solved simply by ordering 50% more of the important alloy steels.

For every one of these steels is dependent upon the alloying elements used in it, and the serious shortage of even one of them prohibits expansion on present lines.

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Molybdenum is an alloying metal chiefly used in small quantities to improve the physical properties of steel.

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Fortunately, more and more Safety and Welfare Officers are realising that Totectors are the one sure way of keeping accident figures down.

The neatly concealed steel toecap affords excellent protection against foot injury.

Every pair carries the Registered Trade Mark and "Safety First Tag" which distinguish all genuine Totector brand boots and shoes.

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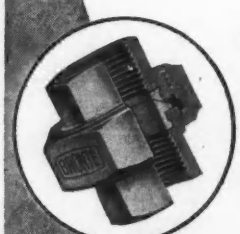

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300 lb. UNIONS

Also—
High Tensile Whiteheart Malleable Iron Castings to British Standard 309 and machined components.

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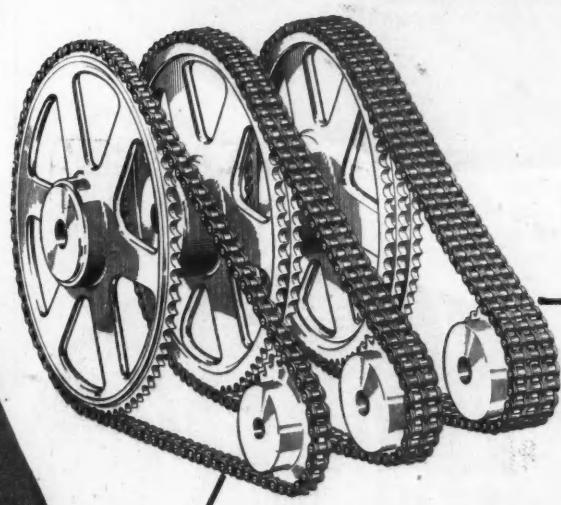

you save SPACE

Drive width is less than for any other form of transmission for a given power, and centres can be reduced to a minimum

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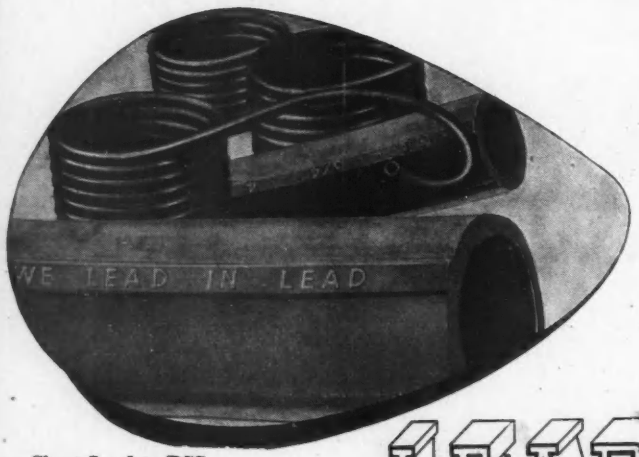
Transmission and Conveying Chains, Wheels and Accessories for all mechanical purposes.



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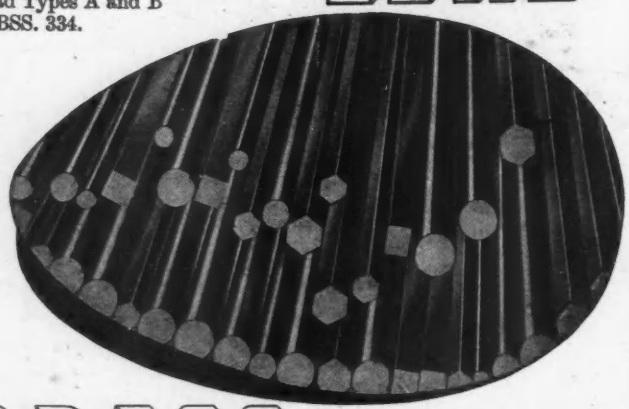
Sheet Lead to BSS. 1178. Lead Piping to BSS. 602. Chemical Lead Types A and B to BSS. 334.



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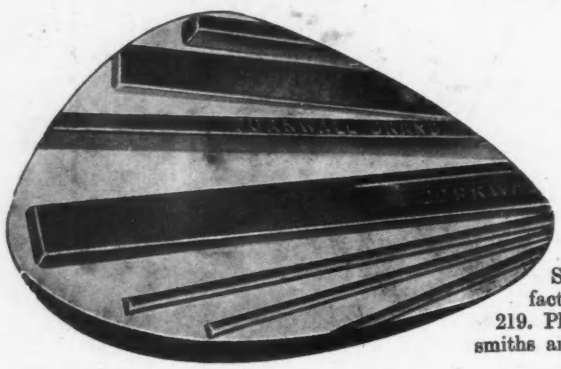

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DELIVERED THROUGHOUT THE COUNTRY BY OUR OWN TRANSPORT

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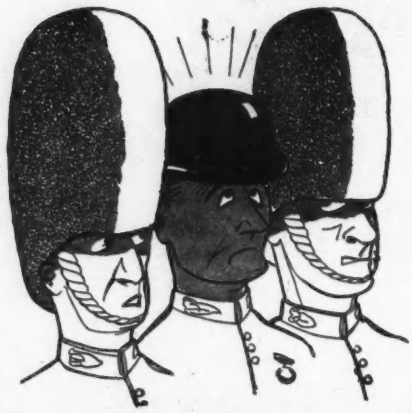

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We've guarded most machines in our time but we specialise in guards for POWER PRESSES, BRAKE PRESSES, HAND PRESSES AND HYDRAULIC PRESSES.

It'll pay you to examine and compare the specification of I.G.E. guards for:

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- Materials
- Workmanship
- Delivery
- Price
- Service

And you'll just have to agree I.G.E. guards have got it all ways!

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THE IDEAL POWER UNIT FOR SMALL PLANTS

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2⅛" CENTRES FITTED WITH BROOK CUB MOTORS

WORM REDUCTION GEAR UNITS

The "Motogear" "R" Type Unit is a motorised worm reduction unit specially designed for direct mounting to Brook "Gryphon" Fractional H.P. motors.

It is made to a similar exacting specification as the other range of "Motogear" products.

Comprehensive literature and certified drawings will gladly be supplied on request.

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Excavating equipment

because it is used under such a wide variety of conditions, and is subject to loads and stresses which are virtually unpredictable, must depend to a large extent for its development upon information secured from operational experience.

The operator in the field

has always been a valuable contributor to the improvement of the Ruston-Bucyrus excavator. He and the user in the various industries —mining, quarrying, building, contracting, etc.—are fruitful sources of knowledge and experience, often providing ideas which the manufacturer through his own internal and field research facilities can translate into useful machine improvements.

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He obtains the benefit of all developments when he acquires a new machine. Now that availability is not such a problem, thought can be given to the question of replacement. Remember, in excavating equipment old friends are not necessarily the best.

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Nitralloy Steels are used with advantage in all types of machinery, particularly for those parts requiring maximum surface hardness and maximum resistance to fatigue.

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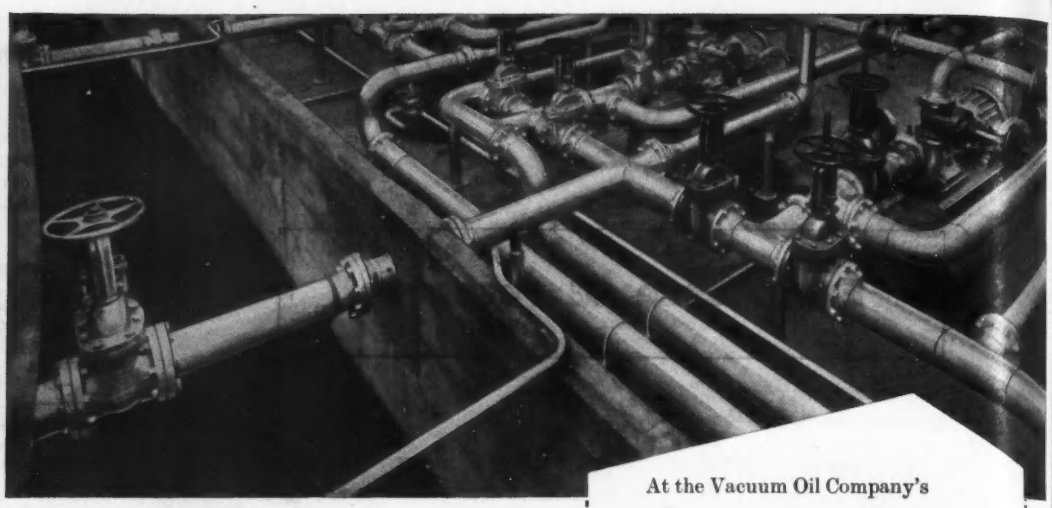
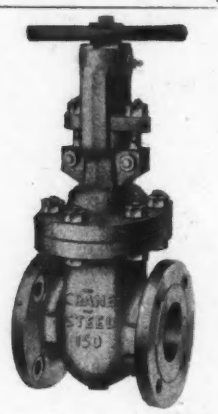


Once again, valves by Crane...

Crane Cast Steel Wedge Gate Valves, 150 pound series, sizes 3" to 8" are used in the installation illustrated above, together with a number of Crane Cast Steel Swing Check Valves.

Contractors (Installation): Messrs. Peter Johnston & Co. (South Shields) Ltd.



At the Vacuum Oil Company's Sunderland terminal, Crane Cast Steel Wedge Gate Valves have been used on *all* pipe lines serving the wharf, storage tanks and product pumps to the filling bays. This comprises about 5,000 ft. of piping, ranging from 3" to 8" diameter! Crane valves are also extensively used in sectionalising the product lines to provide flexibility of the installation and the isolation of pumps, meters and transfer tanks. No wonder the oil and allied industries, who always judge by results, specify Crane.

CRANE VALVES AND FITTINGS

D.11

CRANE LTD., 45-51 LEMAN STREET, LONDON, E.1. Works: IPSWICH *Branches: Birmingham, Brentford, Bristol, Glasgow, Manchester*

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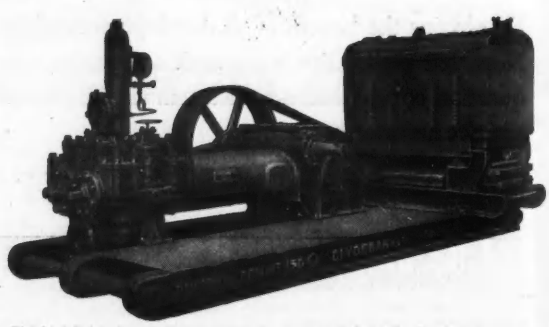
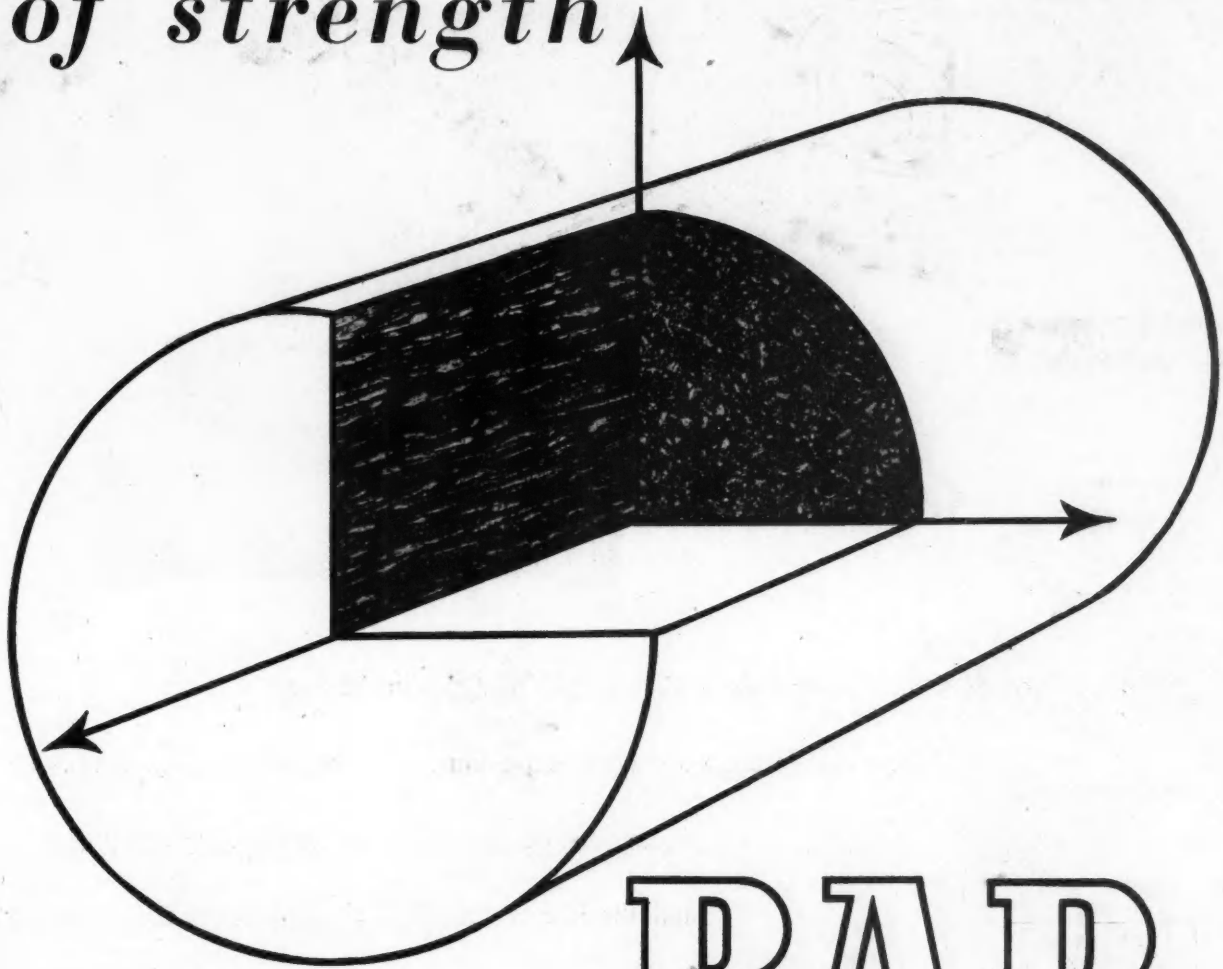


Telegrams : Pumps, Clydebank
Telephone : Clydebank 2271/2/3

The ORIGIN of strength



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HIDURAX
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HIDURIT

Rolled bar owes its strength to the uniform grain structure produced by the rolling process. The two photomicrographs, taken in longitudinal and transverse planes, clearly show this uniformity in a specimen of Hidurax 1 bar. Rolled bar is available from Langley Alloys Limited in the following high-duty materials : Hidurax aluminium bronzes, Hidurel high-conductivity copper alloys, and Hidurit manganese bronzes.

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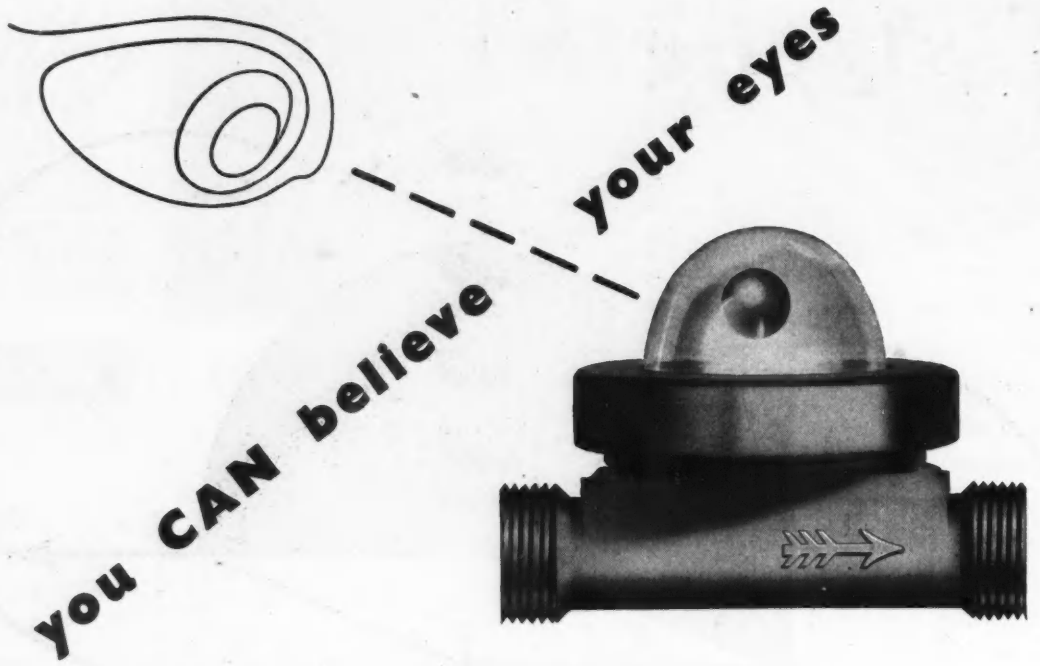

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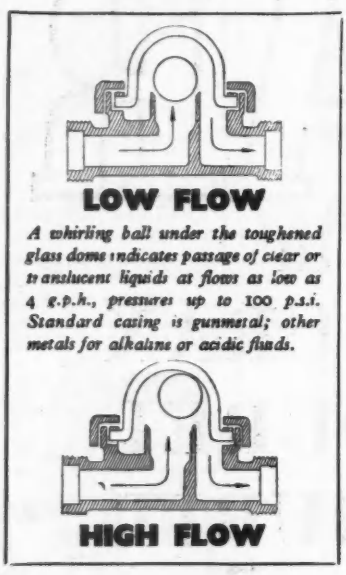
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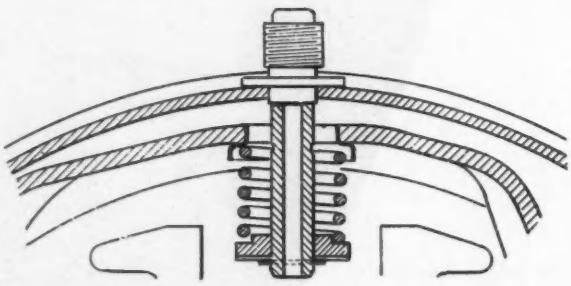

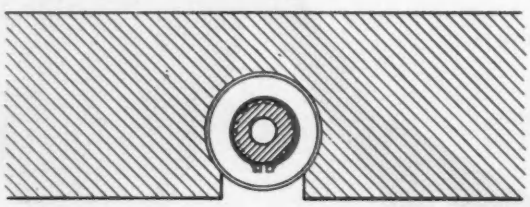

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DUAL DIAL DECADE RESISTANCE BOXES

FOR ALL FREQUENCIES

have now been improved in accuracy to

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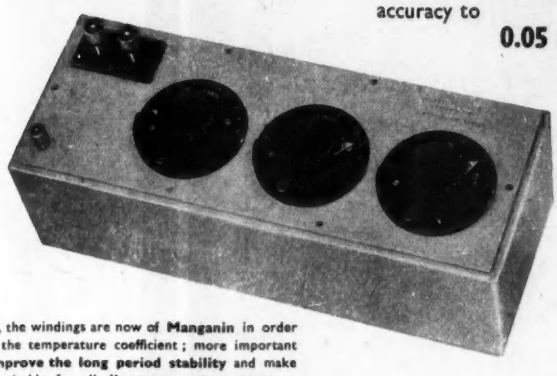

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or three decades of **Tens, Units** and **Tenths** — a total of 100 ohms.
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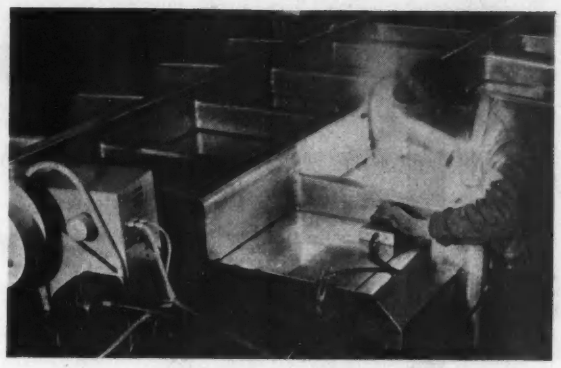

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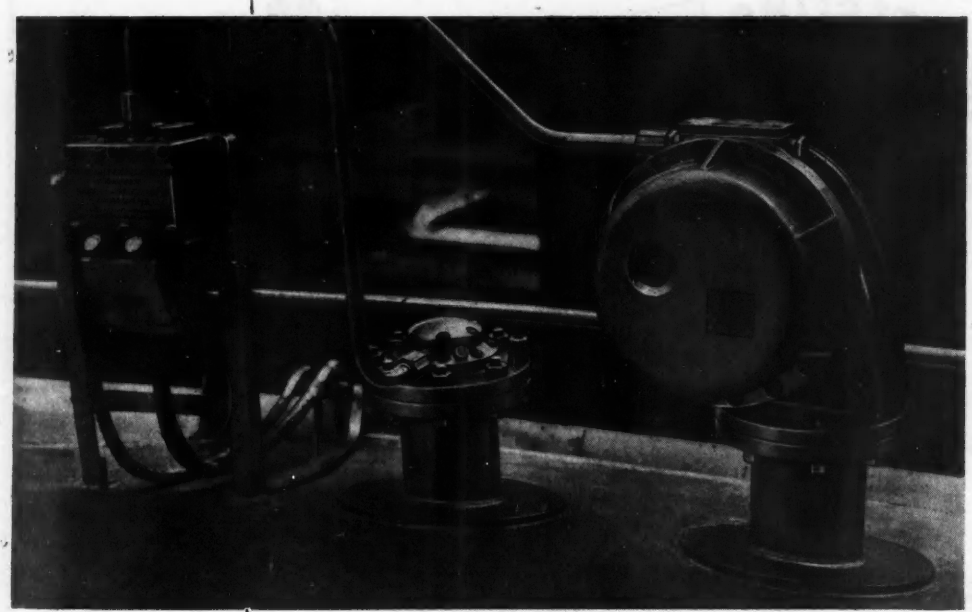

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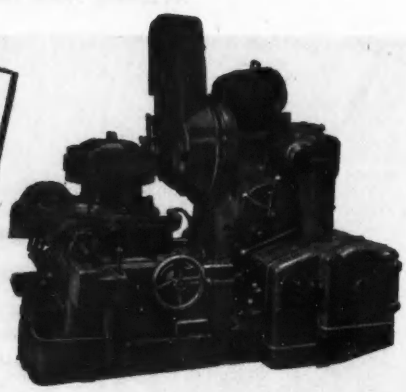

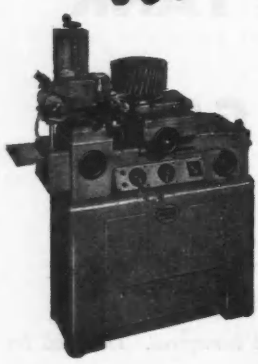

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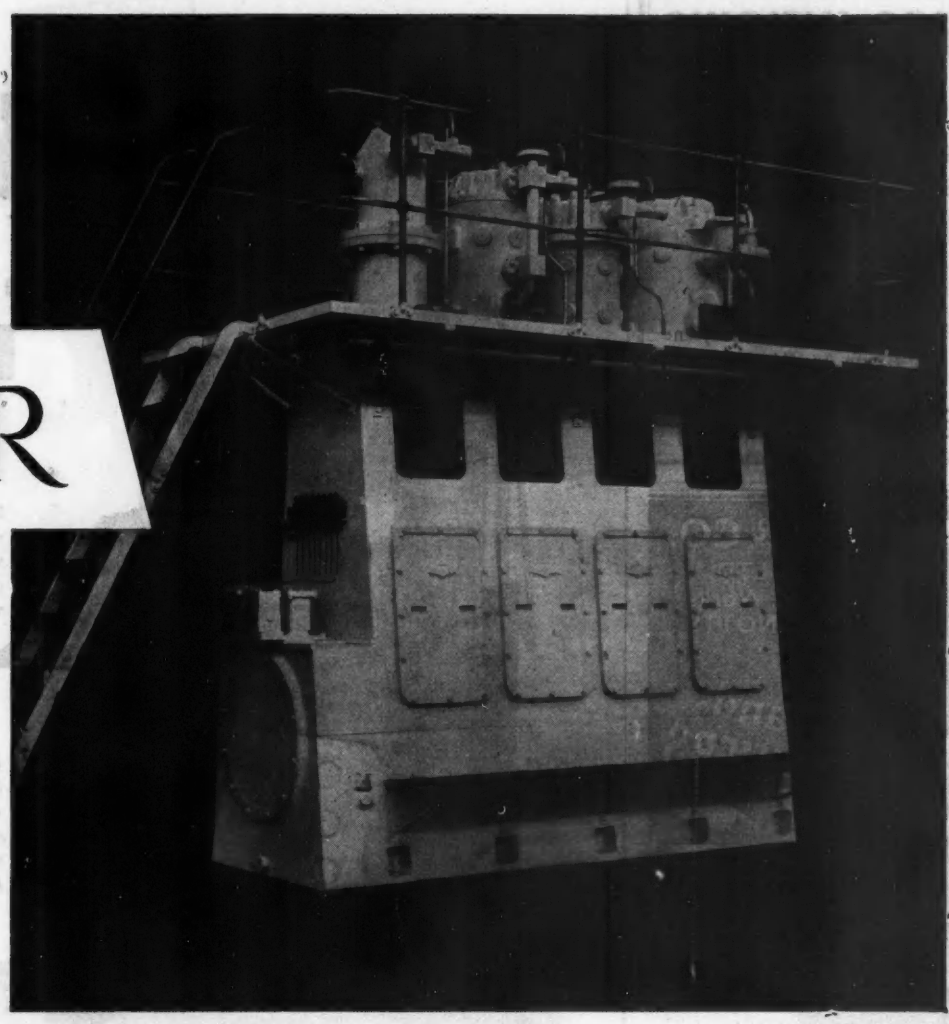

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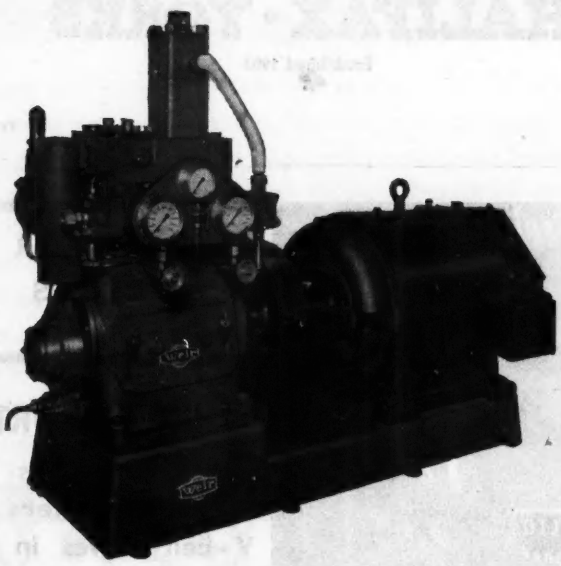

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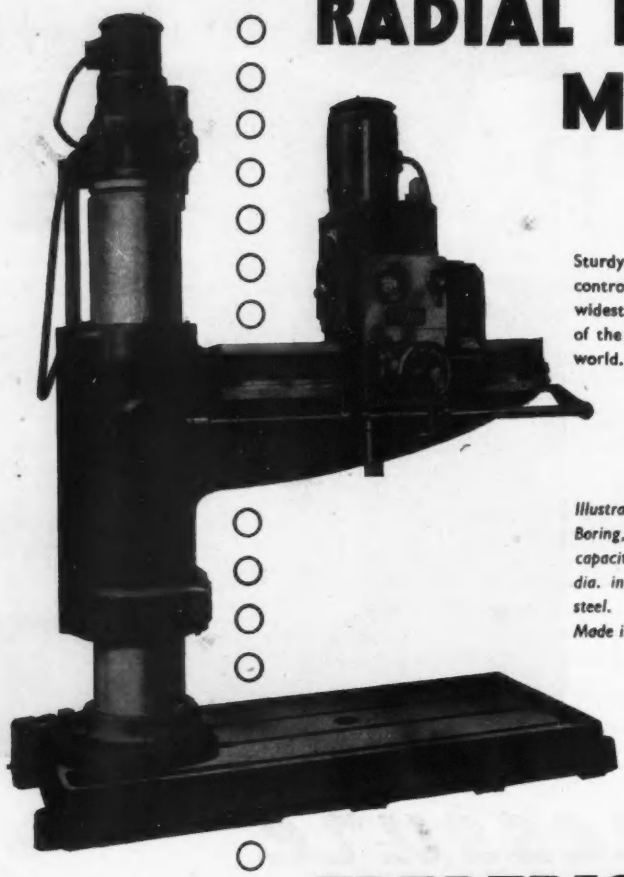

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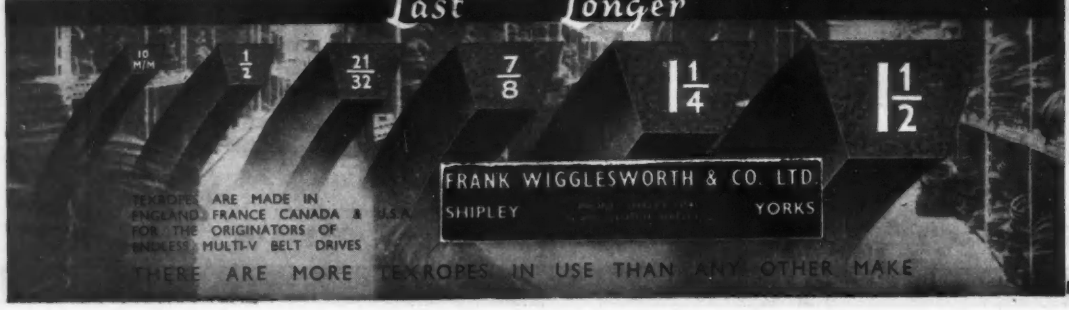
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THERE ARE MORE TEXROPES IN USE THAN ANY OTHER MAKE

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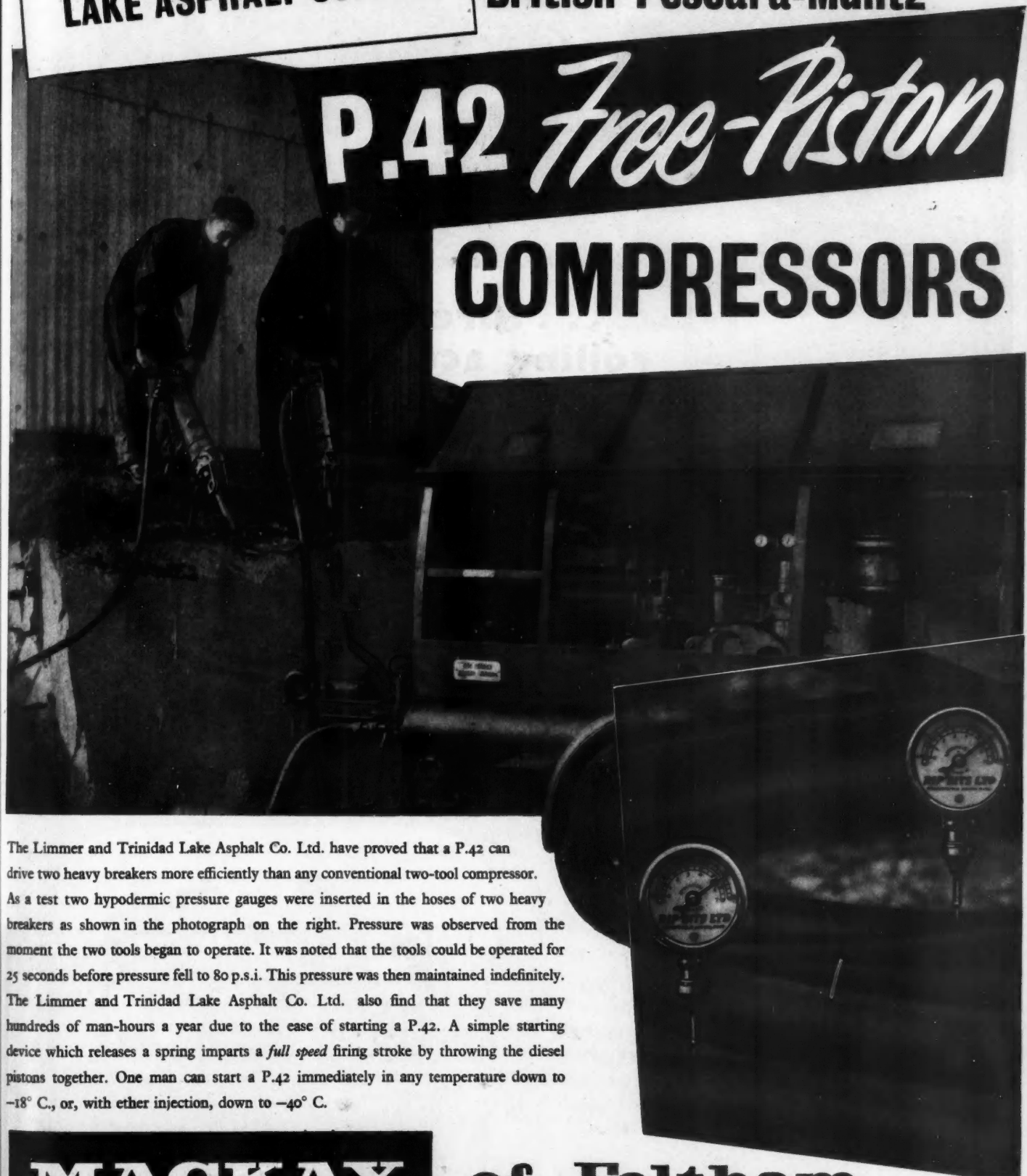

The Limmer and Trinidad Lake Asphalt Co. Ltd. have proved that a P.42 can drive two heavy breakers more efficiently than any conventional two-tool compressor. As a test two hypodermic pressure gauges were inserted in the hoses of two heavy breakers as shown in the photograph on the right. Pressure was observed from the moment the two tools began to operate. It was noted that the tools could be operated for 25 seconds before pressure fell to 80 p.s.i. This pressure was then maintained indefinitely. The Limmer and Trinidad Lake Asphalt Co. Ltd. also find that they save many hundreds of man-hours a year due to the ease of starting a P.42. A simple starting device which releases a spring imparts a *full speed* firing stroke by throwing the diesel pistons together. One man can start a P.42 immediately in any temperature down to −18° C., or, with ether injection, down to −40° C.

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Left. Furnace casing cylinder in Mild Steel Plate 6 ft. dia. × 7/8 in. thick being withdrawn from Bronx Plate Bending Rolls.
Right. Bronx Plate Bending Rolls showing 8 ft. × 1 1/2 in. thick Mild Steel Plate half cylinder in process of being withdrawn.
Photographs by courtesy of Birlec Ltd., Tyburn Road, Birmingham.

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GROUND SERVICING AIR COMPRESSOR.

THIS PLANT WAS SUPPLIED TO B.O.A.C. FOR SERVICING THE HYDRAULIC ACCUMULATORS FITTED TO THE BRITANNIA. FIVE DIFFERENT OUTLET CONNECTIONS GIVE PRESSURES OF 150 - 500 - 1000 - 1500 and 2500 POUNDS PER SQUARE INCH.

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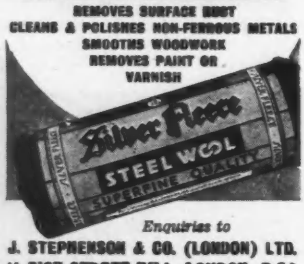

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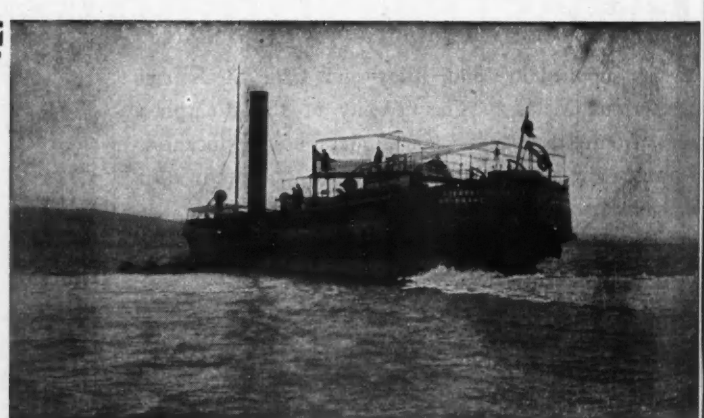

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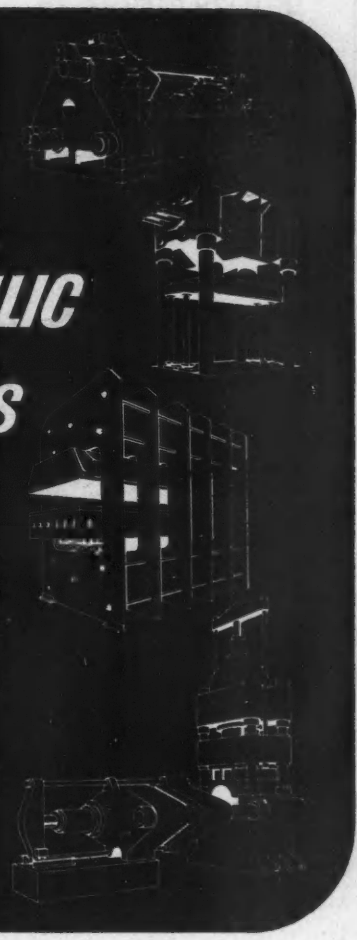
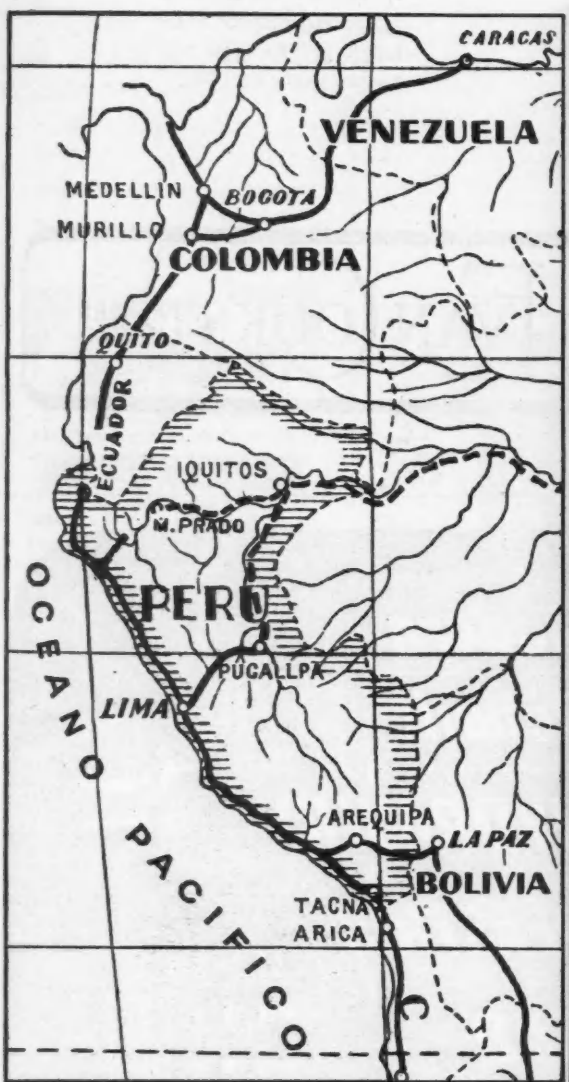
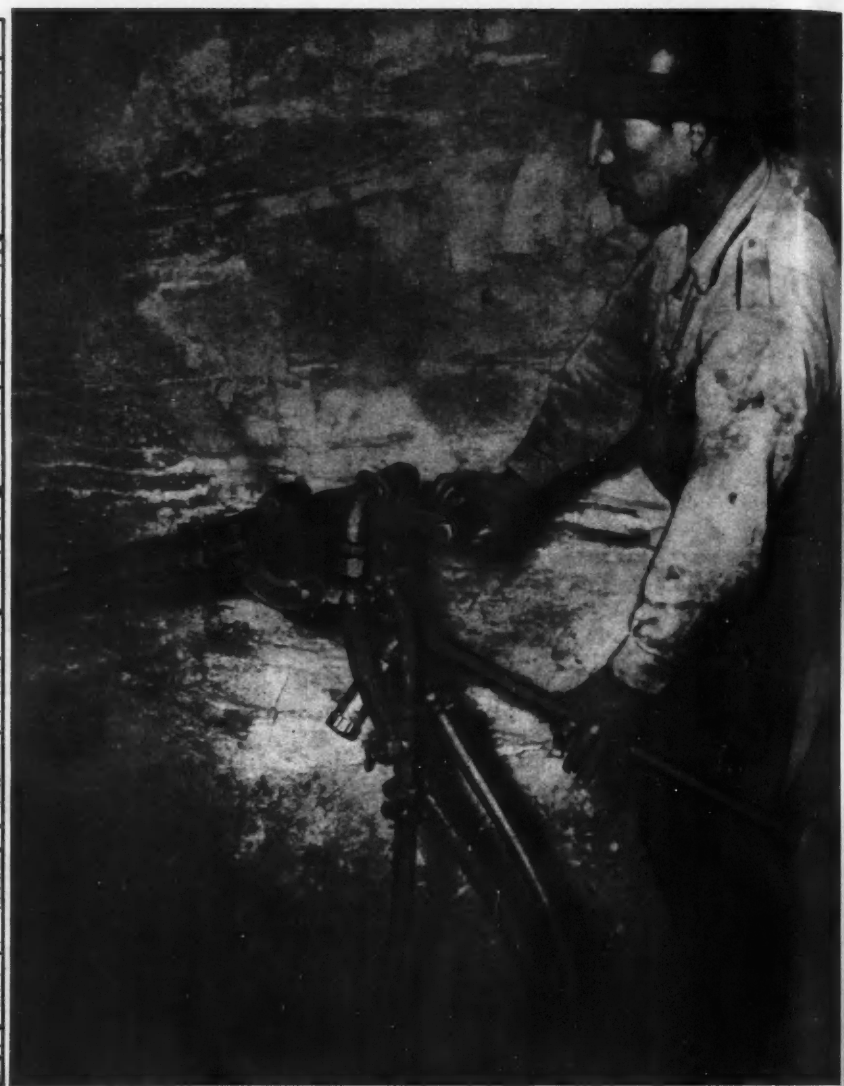


TUNNEL CONSTRUCTION IN PERU FOR PAN-AMERICAN HIGHWAY...

Work is now well ahead on the Pan-American Highway which, when completed, will run from Buenos Aires in the Argentine, through the whole of South America and Mexico up to the United States. The highway is reported already completed in the Argentine and, to some extent, in Chile and Peru as well. And so steadily this vast project —comparable to the Burma Road and Alaskan Highway in its scope—takes form as it progresses towards North America.





Right. One of fifty Atlas Copco light rock drills—one-man machines—now at work on the Pan-American Highway. All of these are fitted with Sandvik Coromant tungsten-carbide-tipped drill steels

THROUGH MOUNTAINS

In 1950, the Peruvian Government presented its total programme for the construction of the highway through their country. A start was made from the capital, Lima. In 1954, 310 miles of the highway had been completed. It was then possible to commence work on the more difficult sections which are to run through mountain ranges in southern Peru. This involved a great number of blasting operations and also meant the driving of several tunnels.

ATLAS COPCO EQUIPMENT

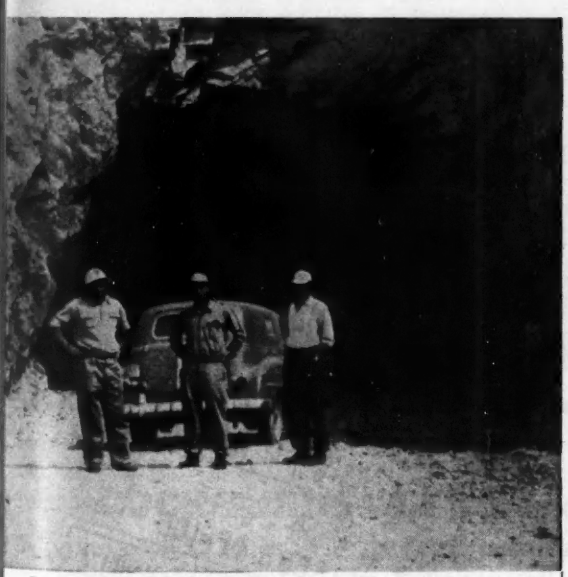
Two of the tunnels have now been completed. One is 390 feet long, with an area of 430 square feet. The other, 900 feet long. The equipment to drill these tunnels is exclusively Atlas Copco — also used to an extensive degree on the roads. (This equipment was supplied by Compañía Atlas del Perú.) At work are fifty Atlas Copco light rock drills, all fitted with Sandvik Coromant tungsten-carbide-tipped drill steels, the world's most widely used integral steels. Other Atlas Copco equipment used on the construction of the Pan-American Highway includes seven compressors and a number of loaders.

MORE DRILLS AND SMALLER CREWS

The Pan-American Highway in Peru is yet another construction project to benefit from employing Atlas Copco light rock drills fitted with Coromant tungsten-carbide-tipped drill steels. The light drills are *one-man machines enabling a greater number of drills operated by smaller drilling crews to be engaged simultaneously on actual drilling operations at the face.* The result is shorter drilling times for each round and overall greater progress. This is the method that is bringing faster, smoother, more economical drilling all over the world.

Atlas Copco Compressed Air Equipment is manufactured or sold and serviced in 48 countries throughout the world by *The Atlas Copco Group*, which embraces companies trading under various names such as Atlas, Atlas Diesel, Atlas Polar, Atlas Copco, Copco, Delfos and Sampa.

One of the Atlas Copco HR4V Compressors operating on highway construction work. These compressors are famous for their rugged and simple design, reliability and economy.



The service wagon of Compañia Atlas del Perú at the entrance of one of the tunnels.

Atlas Copco LM 100 loader removing the rock for the new highway. The design of the bucket enables the biggest boulders to be removed.

MAIL THIS COUPON to the most convenient of the addresses given here:

UNITED KINGDOM, The Atlas Diesel Co., Ltd., Wembley, Middx; FRANCE, Atlas Polar S.A., 29, Rue Marbeuf, Paris 8e; HOLLAND, N.V. Holland-Atlas, P.O. Box 6056, Rotterdam; ITALY, S.A.M.P.A., Viale Marche 15, Milan.

CANADA, Canadian Copco Ltd., Montreal, A.M.F.; AUSTRALIA, Australian Atlas Co. Pty. Ltd., P.O. Box 54, Auburn, N.S.W.; SOUTH AFRICA, Delfos Pty. Ltd., P.O. Box 504, Benoni, Transvaal.

U.S.A., Copco Pacific, Ltd., 930 Brittan Avenue, San Carlos, California; Copco Eastern, Ltd., P.O. Box 2568, Paterson 2, N.J.

Readers in countries outside those listed above and who do not know the name of their local Atlas Copco company or agent, please write, in the first instance, to AB, Atlas Diesel, Stockholm 1, Sweden.

Please forward details of ***Atlas Copco Rock Drills and Sandvik Coromant Drill Steels***

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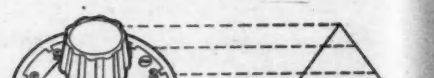

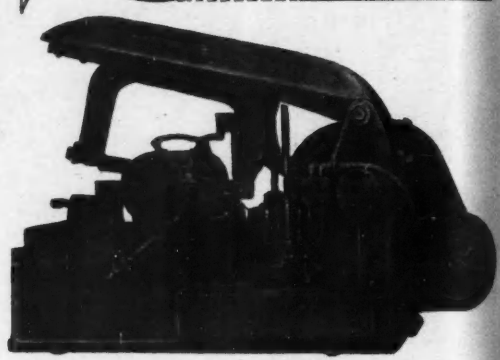

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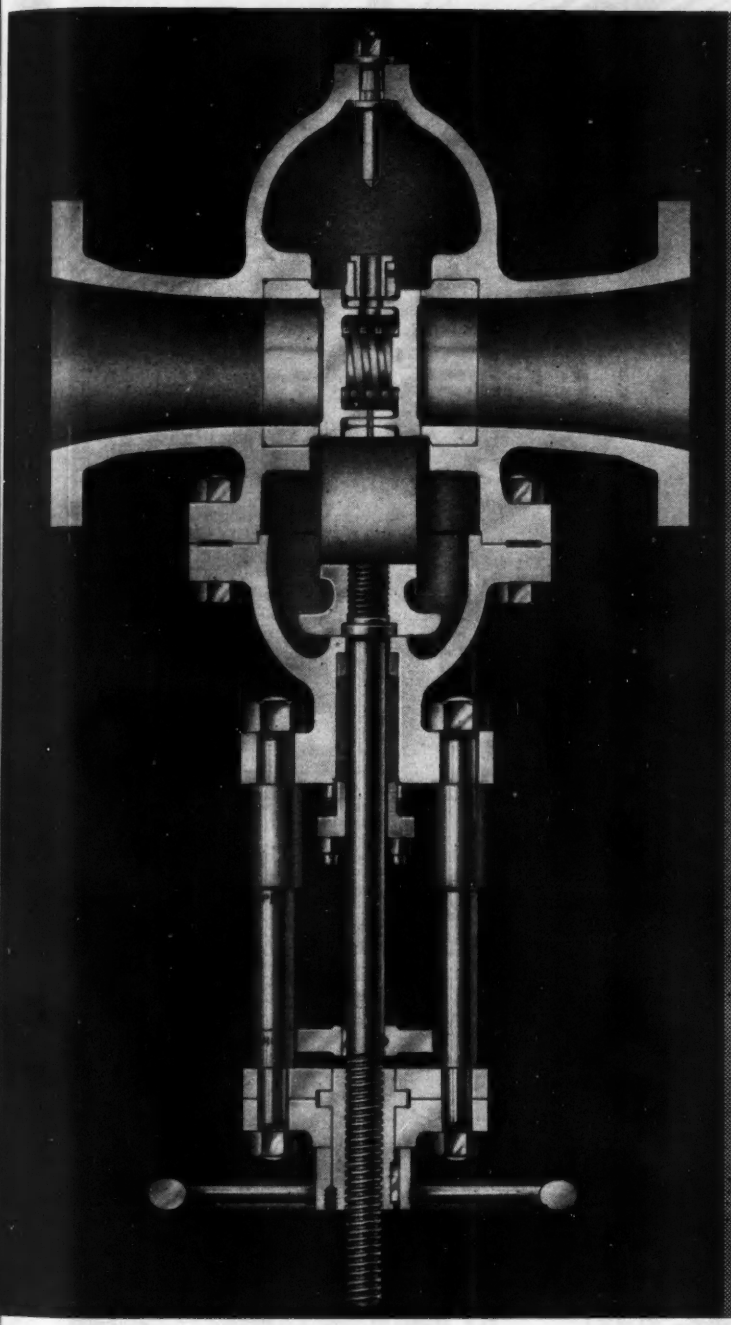

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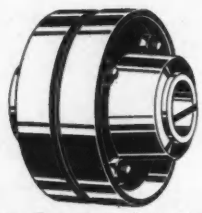
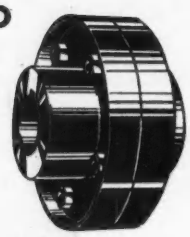
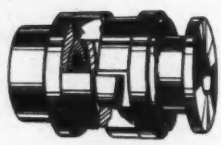


Spiro Compression type



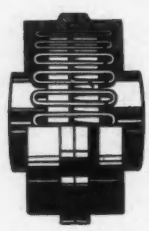
Rigid Pulley type



Claw type

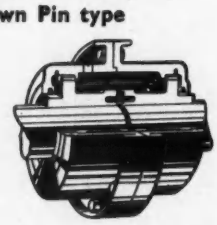
FLEXIBLE

Crown Pin type



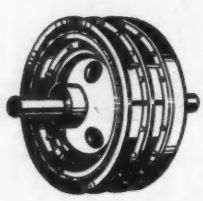
Multiflex type

Perfect type

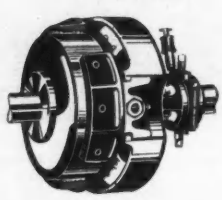


Internal Gear type

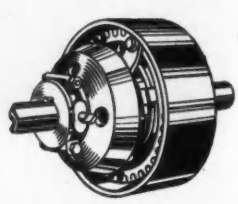
FRICTION



Airflex Friction type



Rim Friction type



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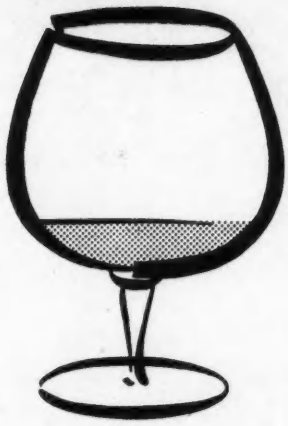

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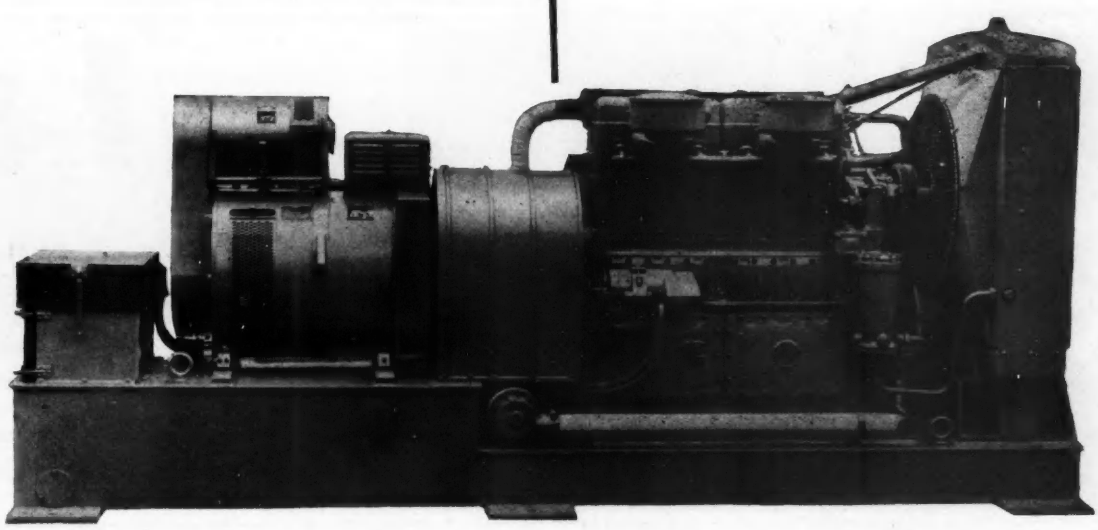

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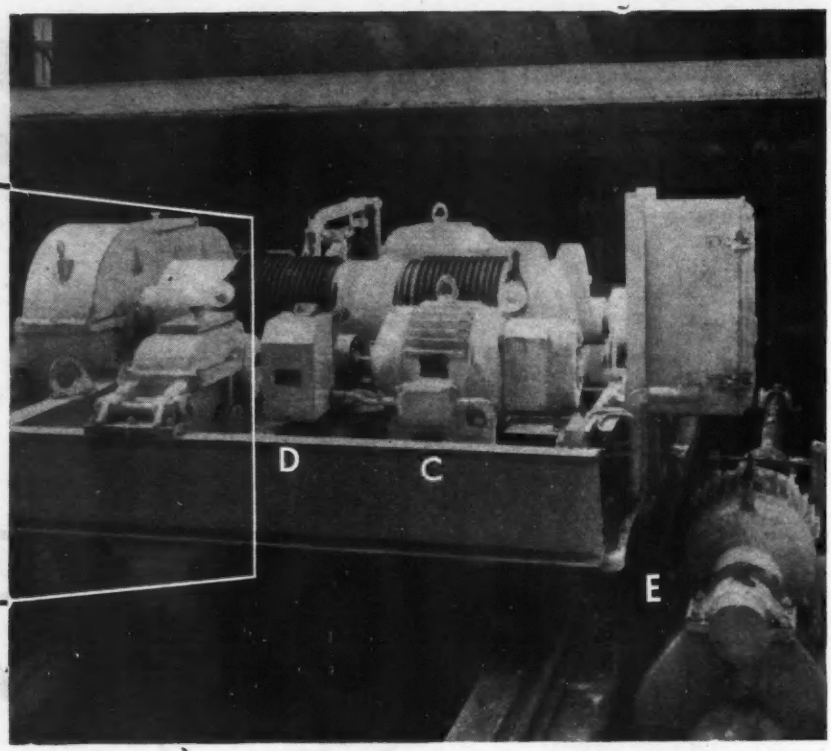

A 3-h.p. cross traverse motor is seen at C, the 6" Perigrip Brake at D, and the long-travel drive motor is shown at E.

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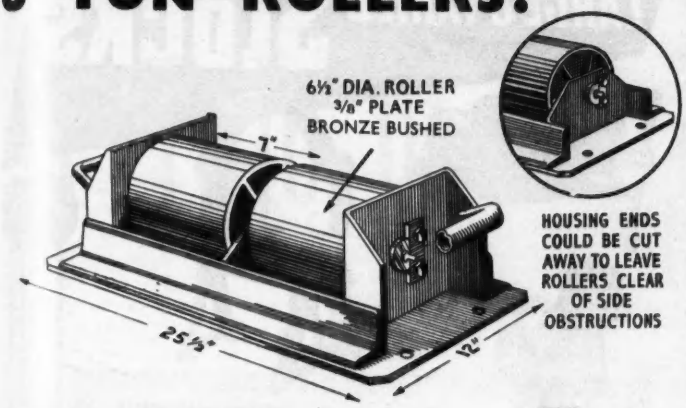

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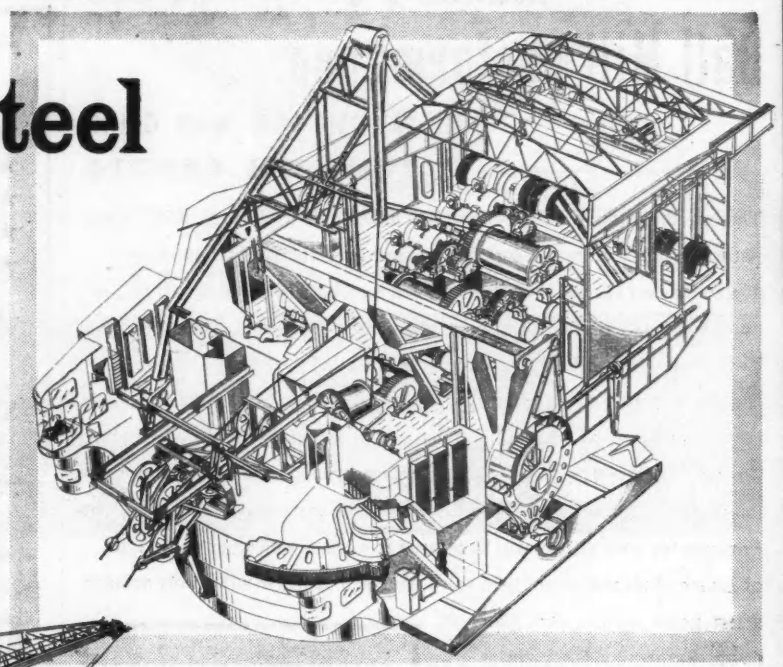

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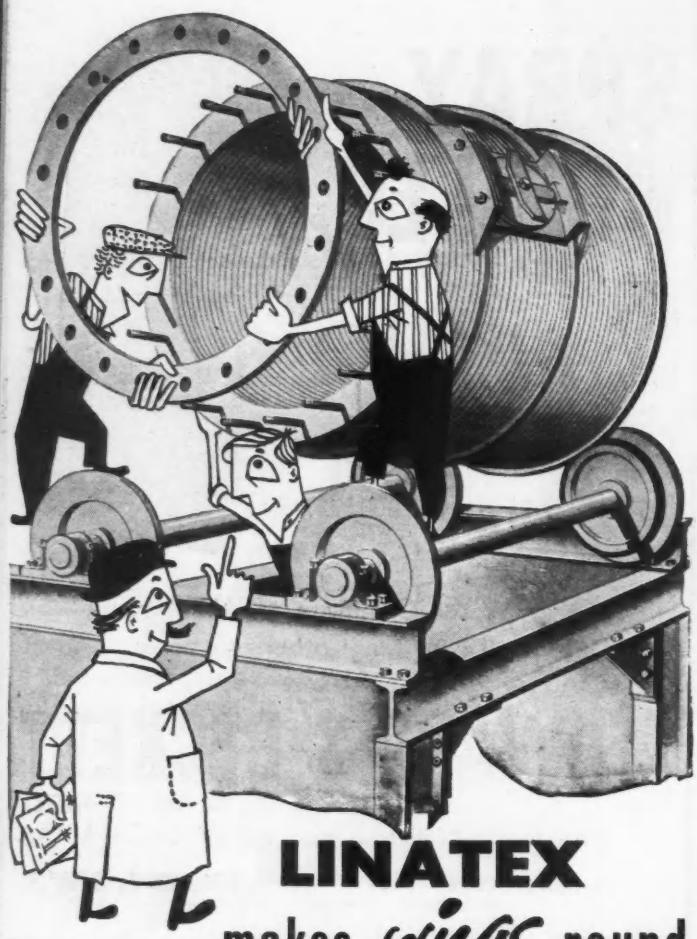

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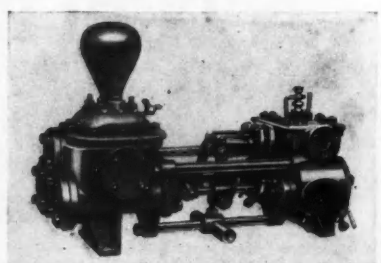

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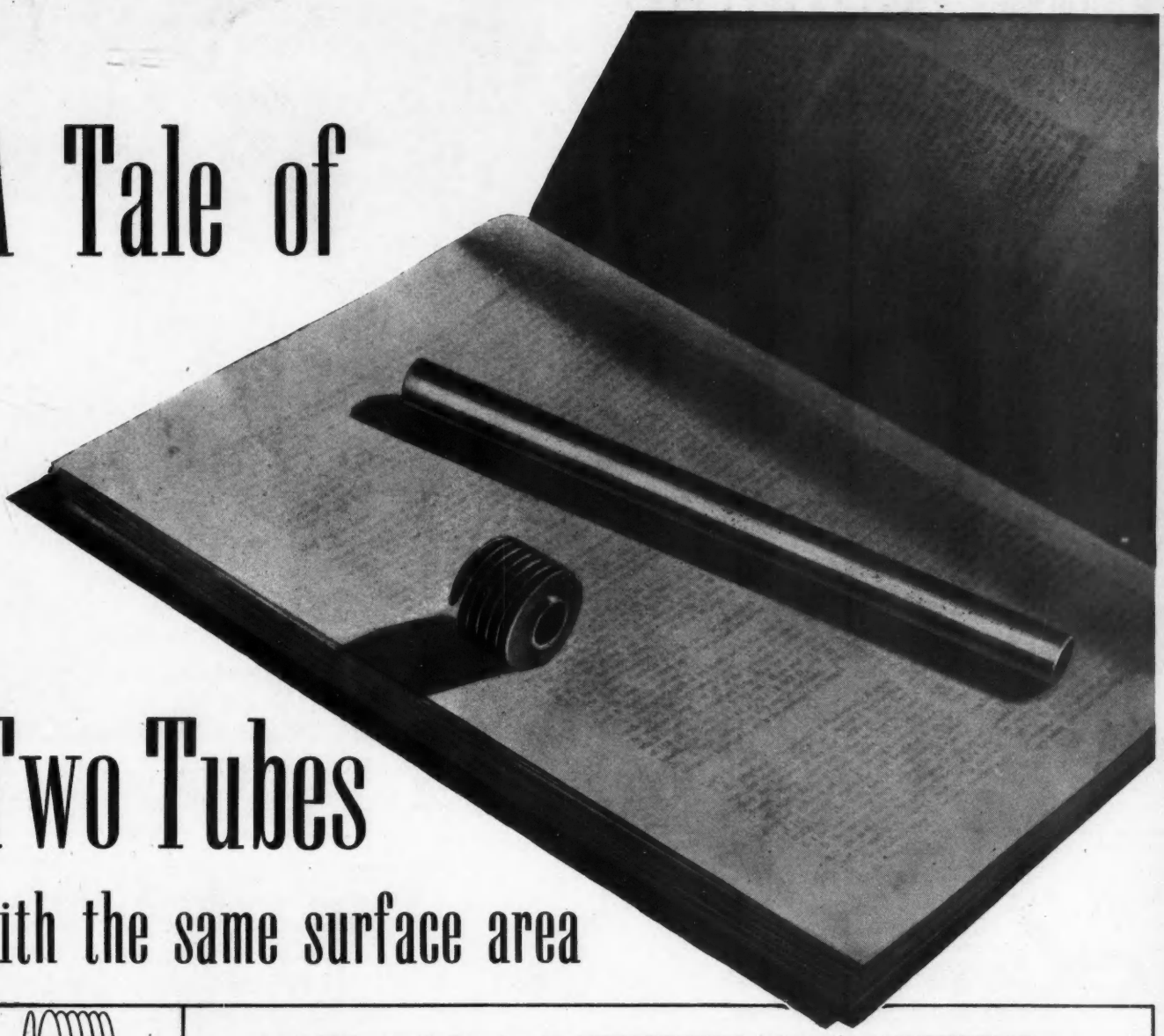

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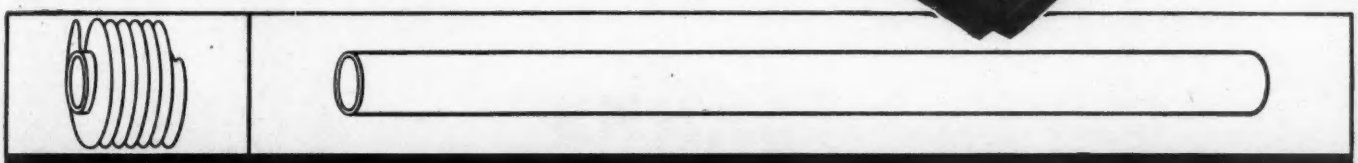

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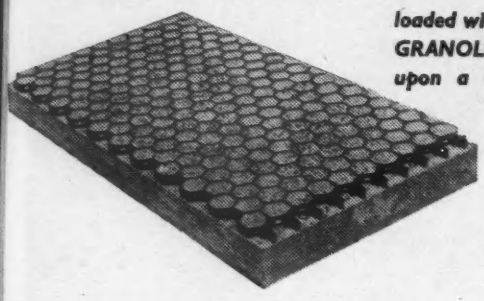

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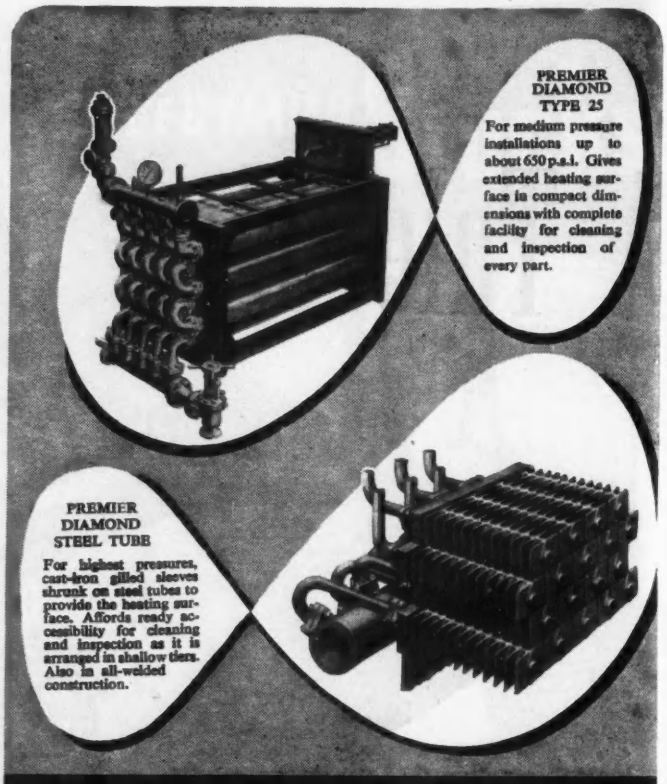
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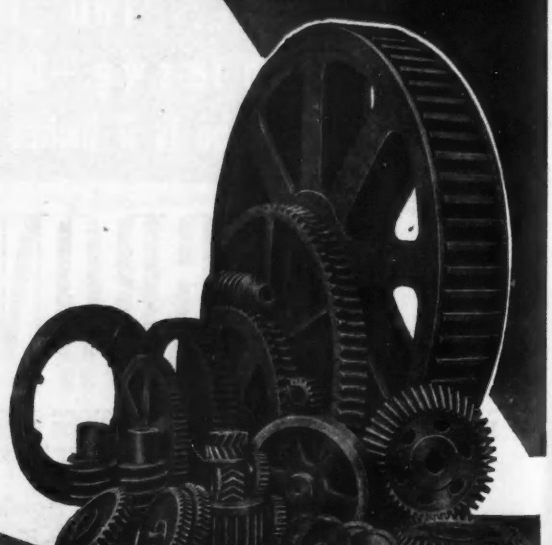

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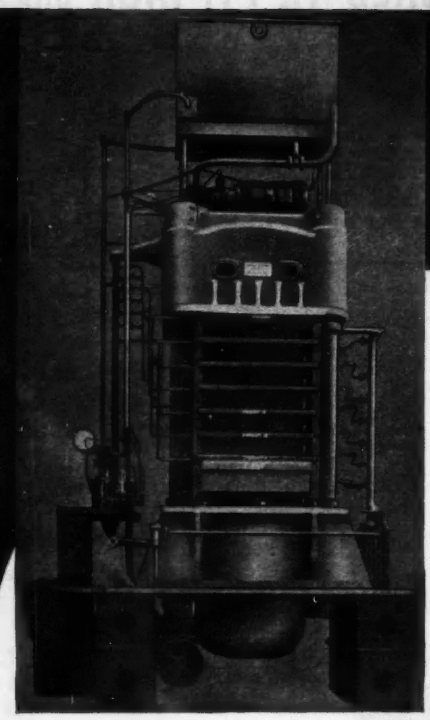

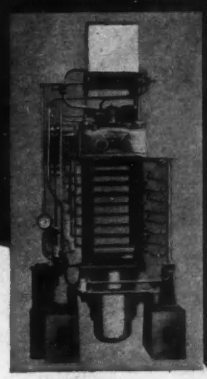

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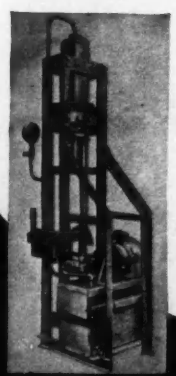

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The Engineer

BUYERS GUIDE 1955

Published on January 21st

CONTENTS

Associations, Institutions and Societies Connected with the Engineering Industry.
Address Section.
Telegraphic Addresses.
Trade Names and Marks.
Buyers Guide (25,000 entries)
U.K. Agents for Foreign Firms.

Subscribers to 'The Engineer' were sent one free copy through the post, and copies were supplied to newsagents for delivery to regular readers of 'The Engineer' with the January 21st issue.

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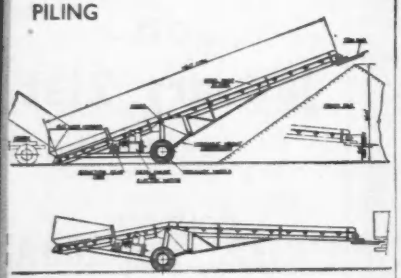

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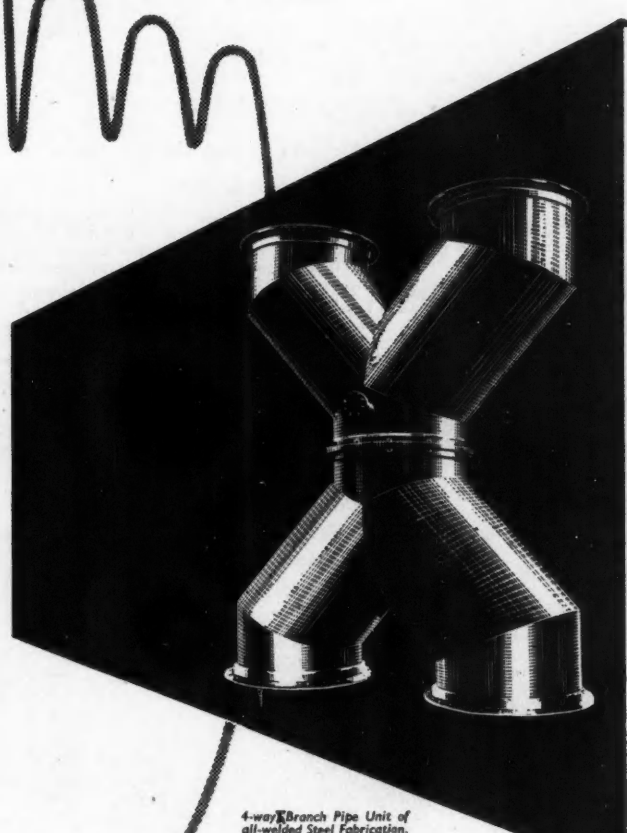

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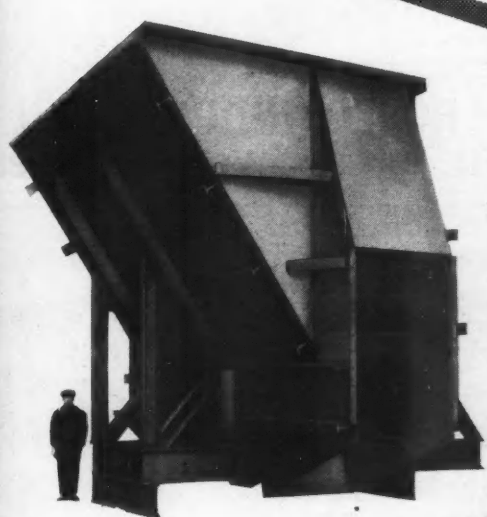

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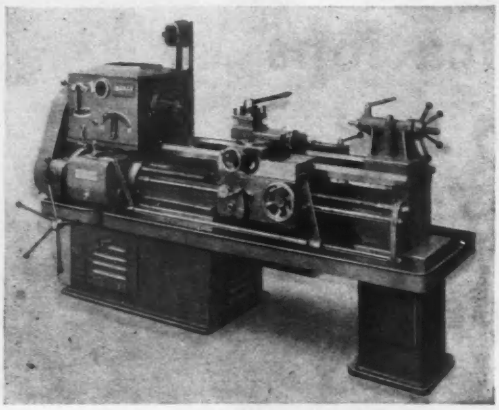

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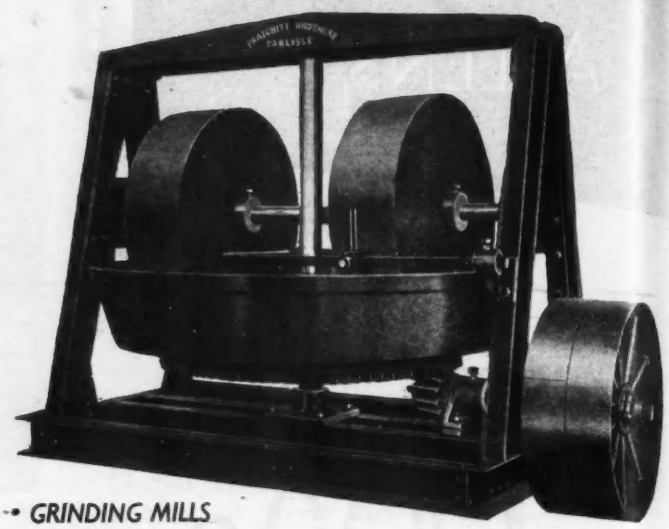

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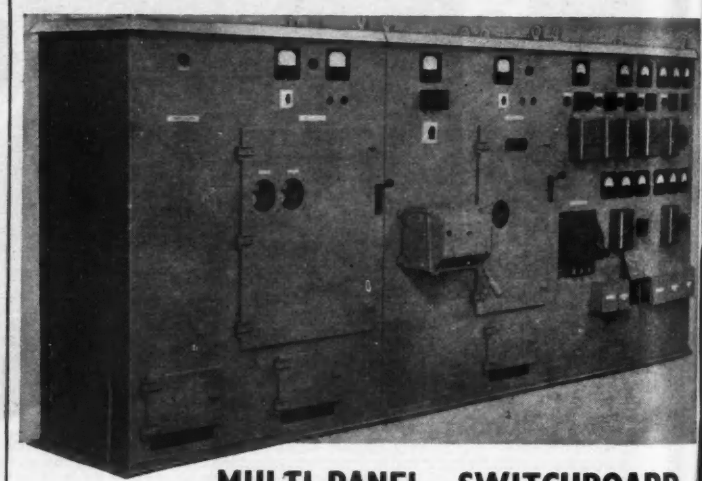

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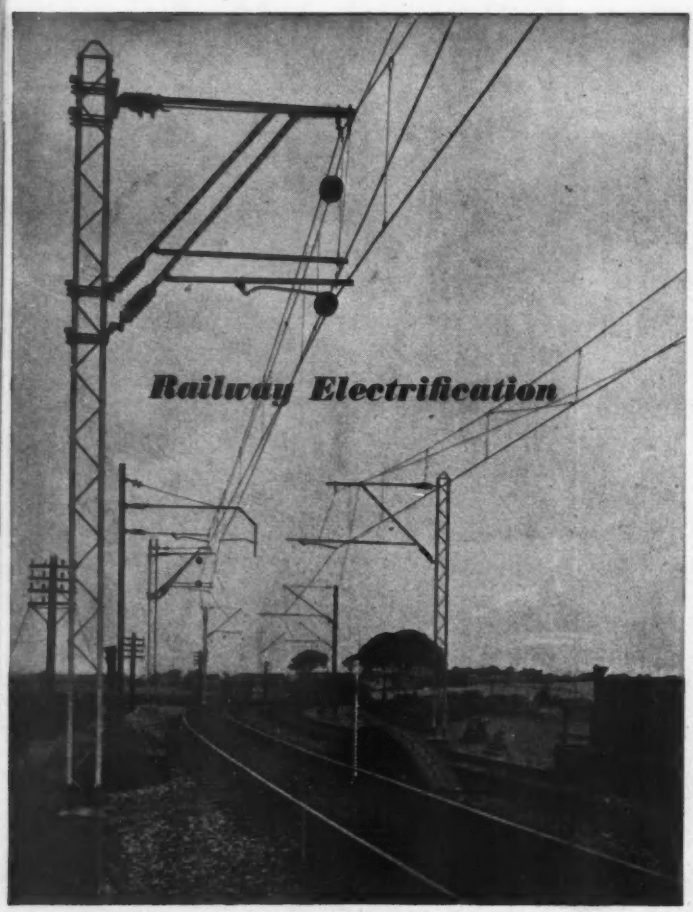

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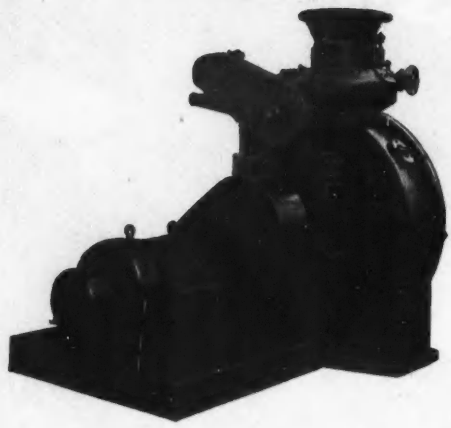

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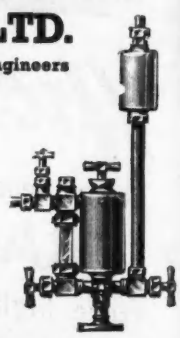

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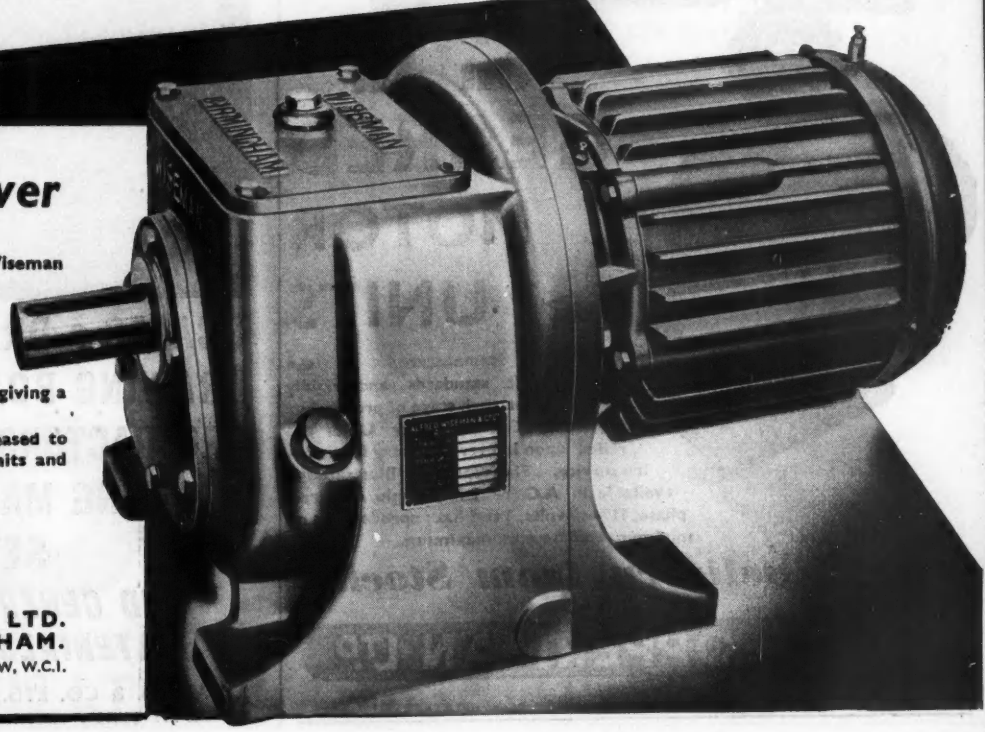

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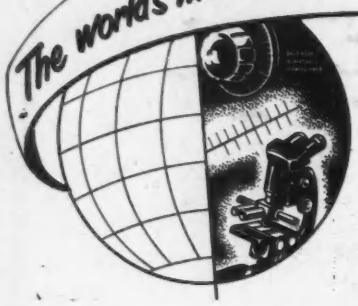

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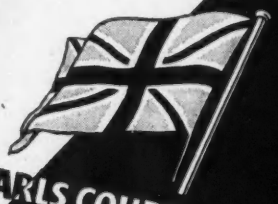

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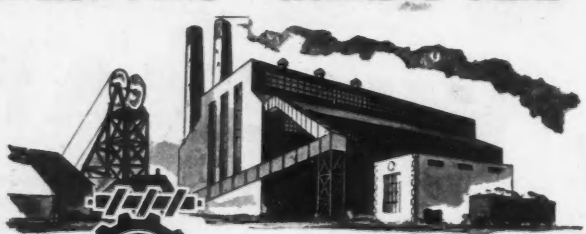

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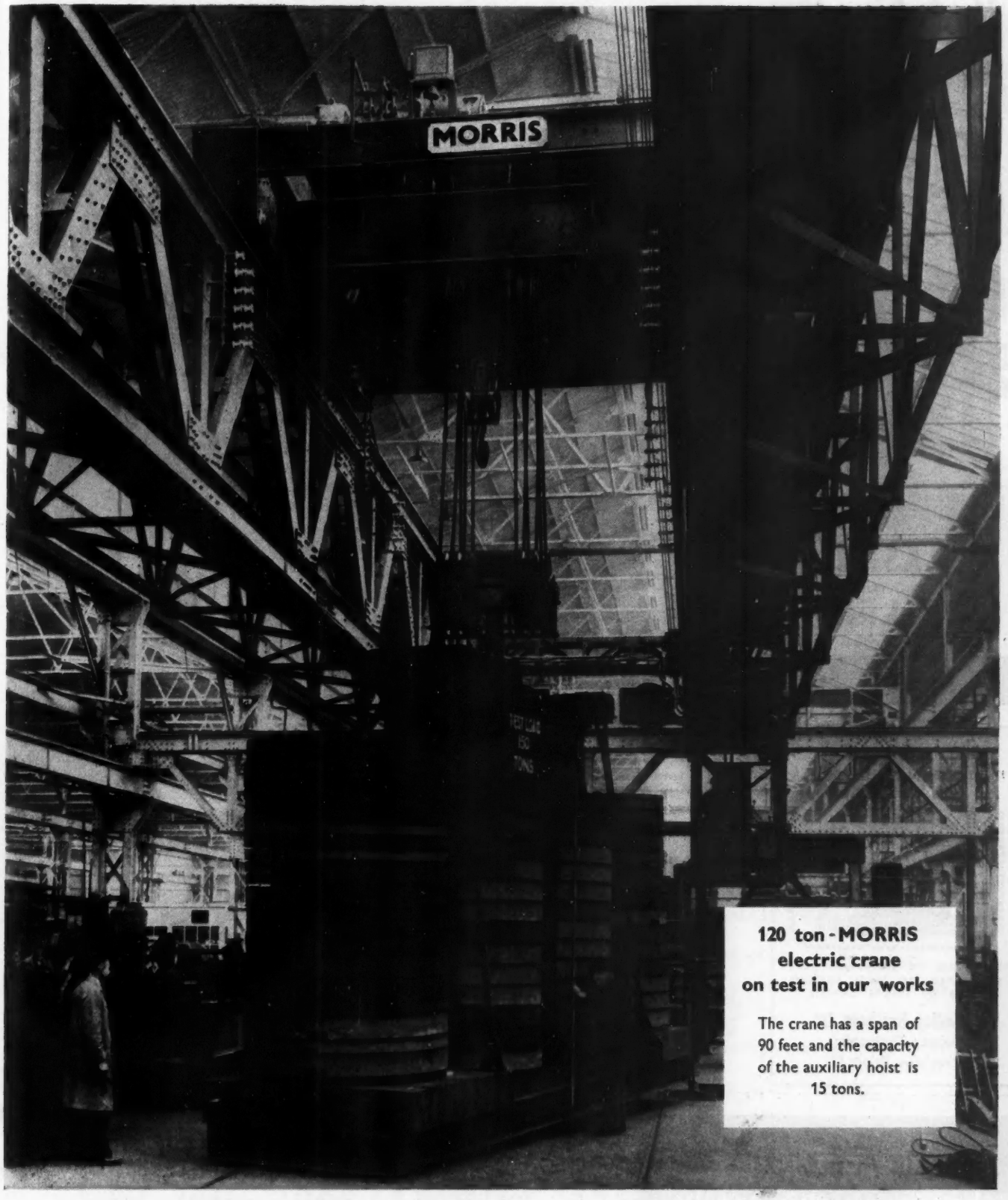

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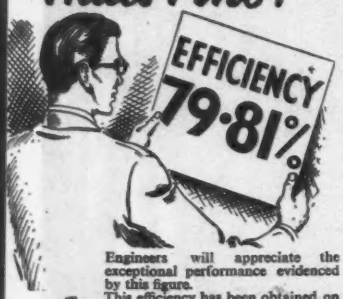

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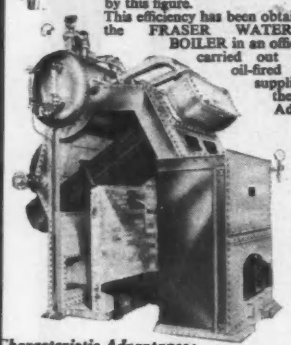

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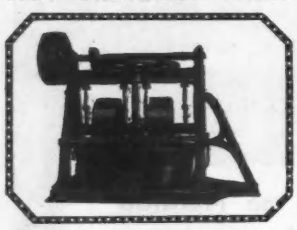

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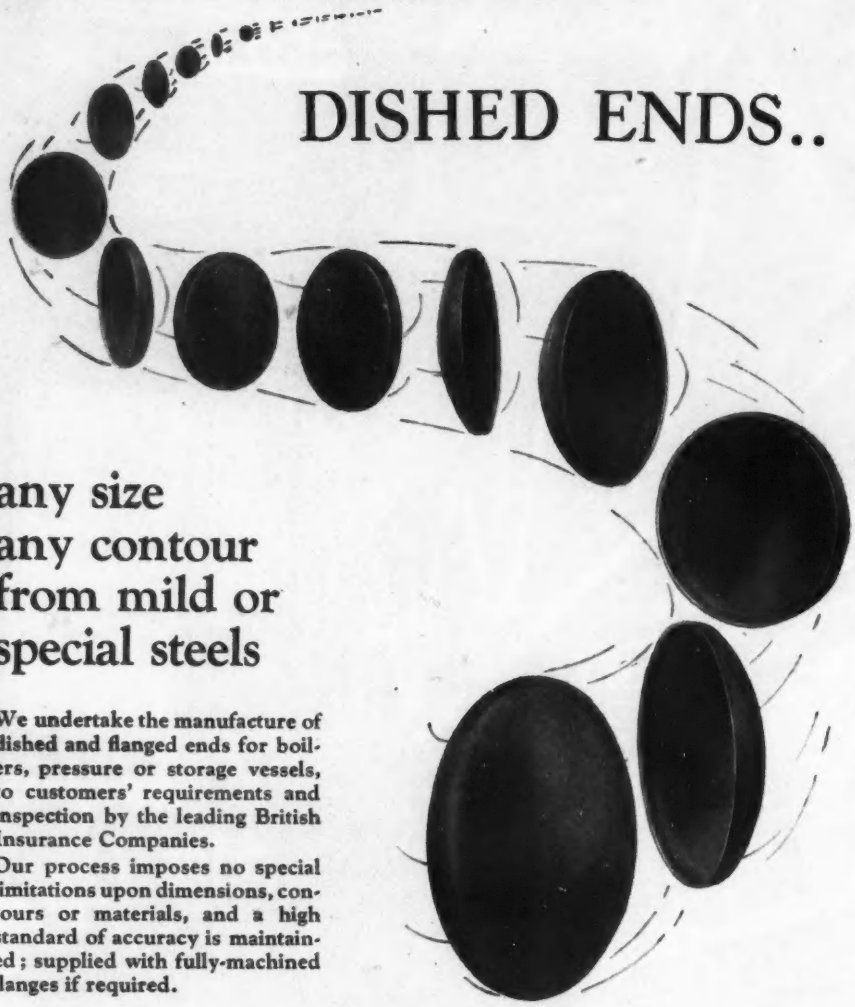

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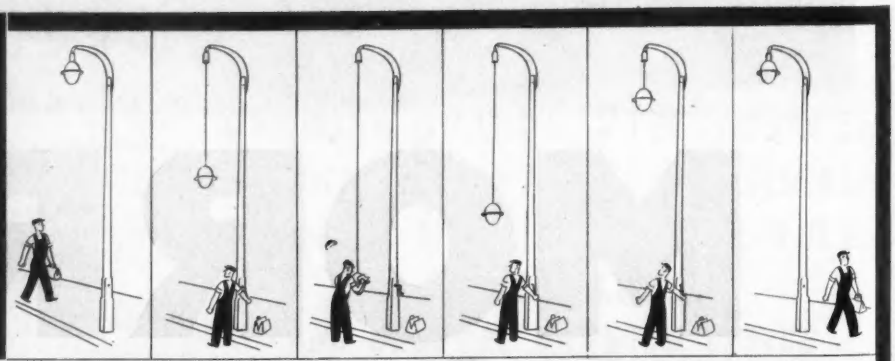

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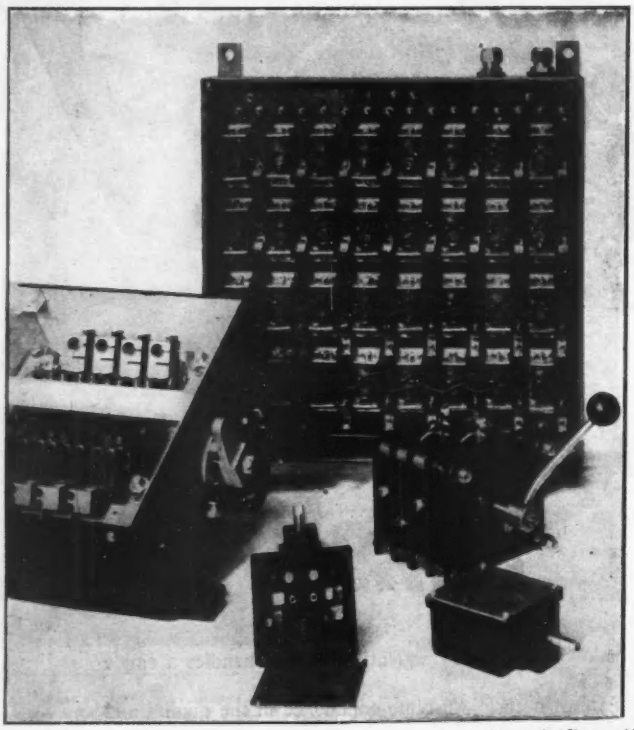

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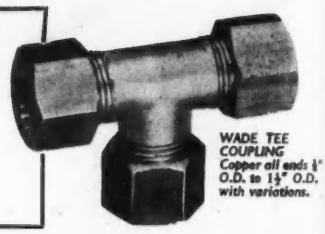

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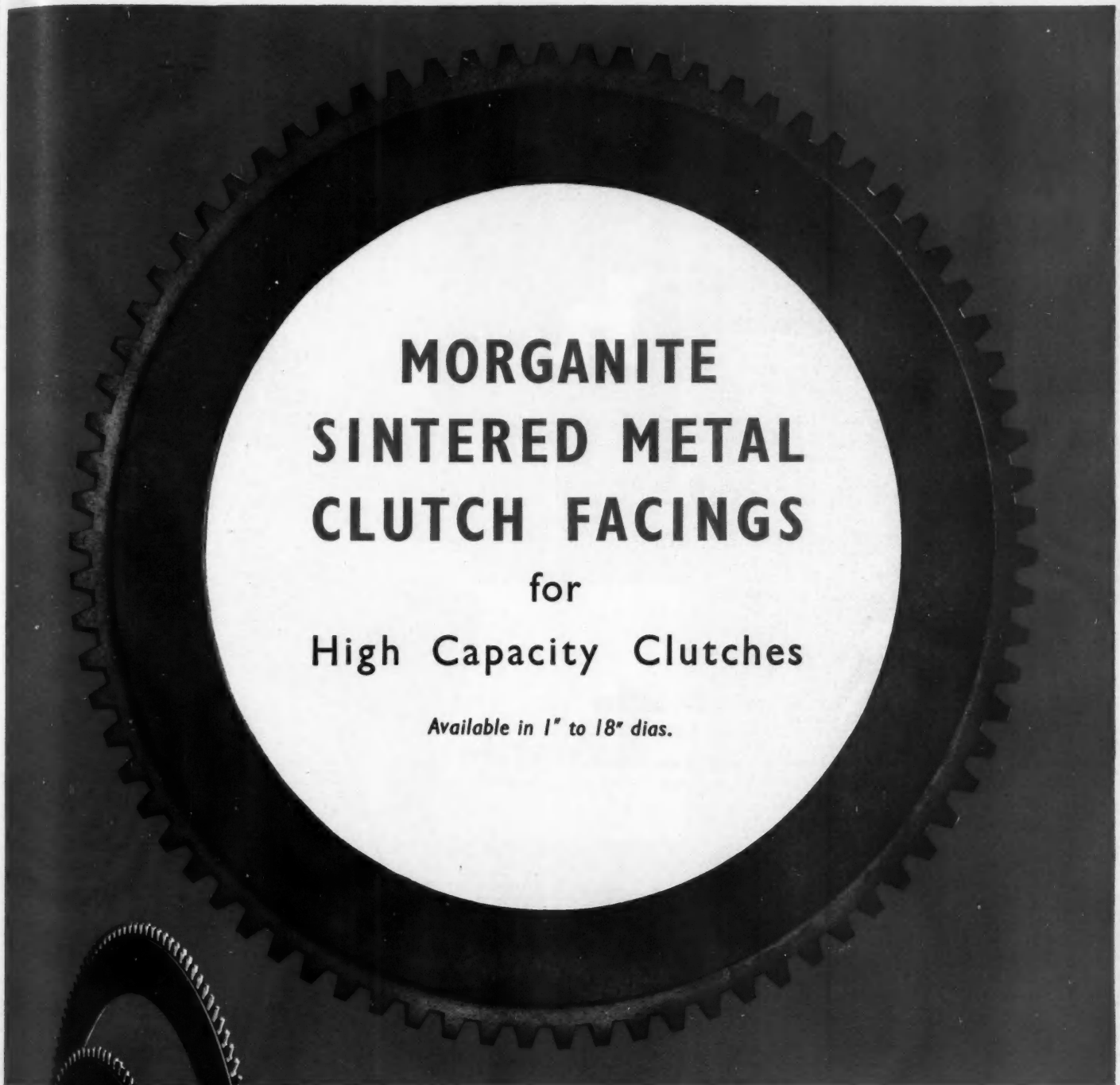

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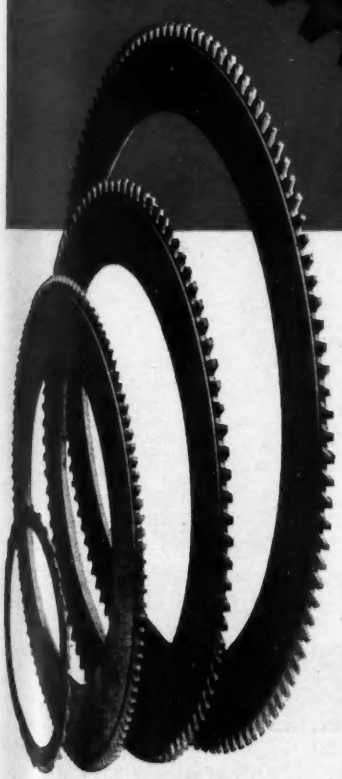

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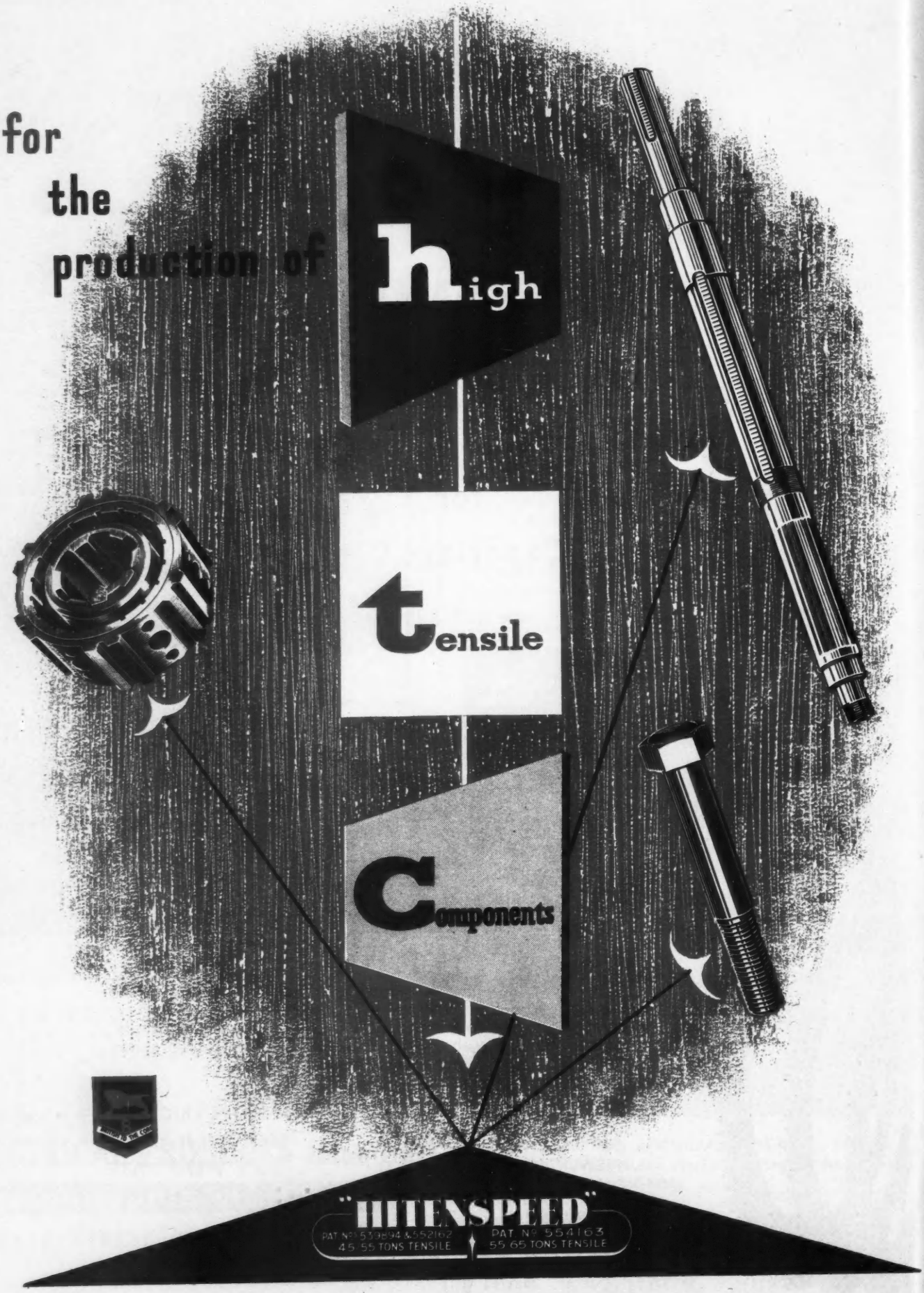

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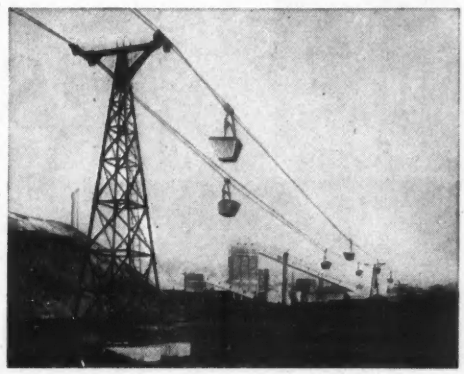

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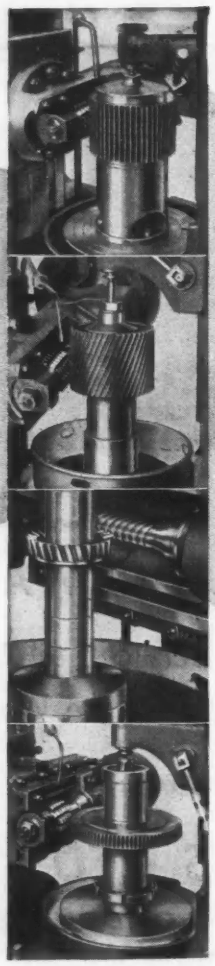

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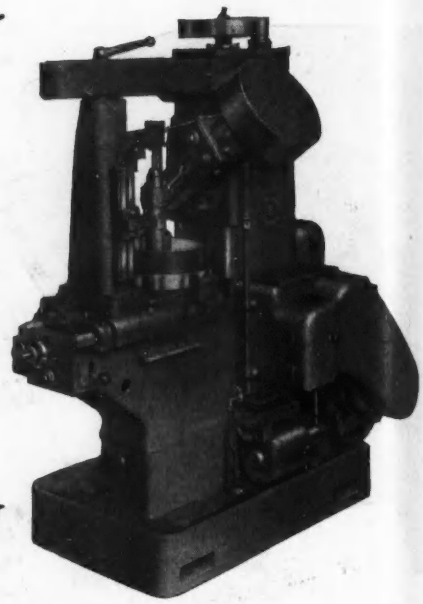

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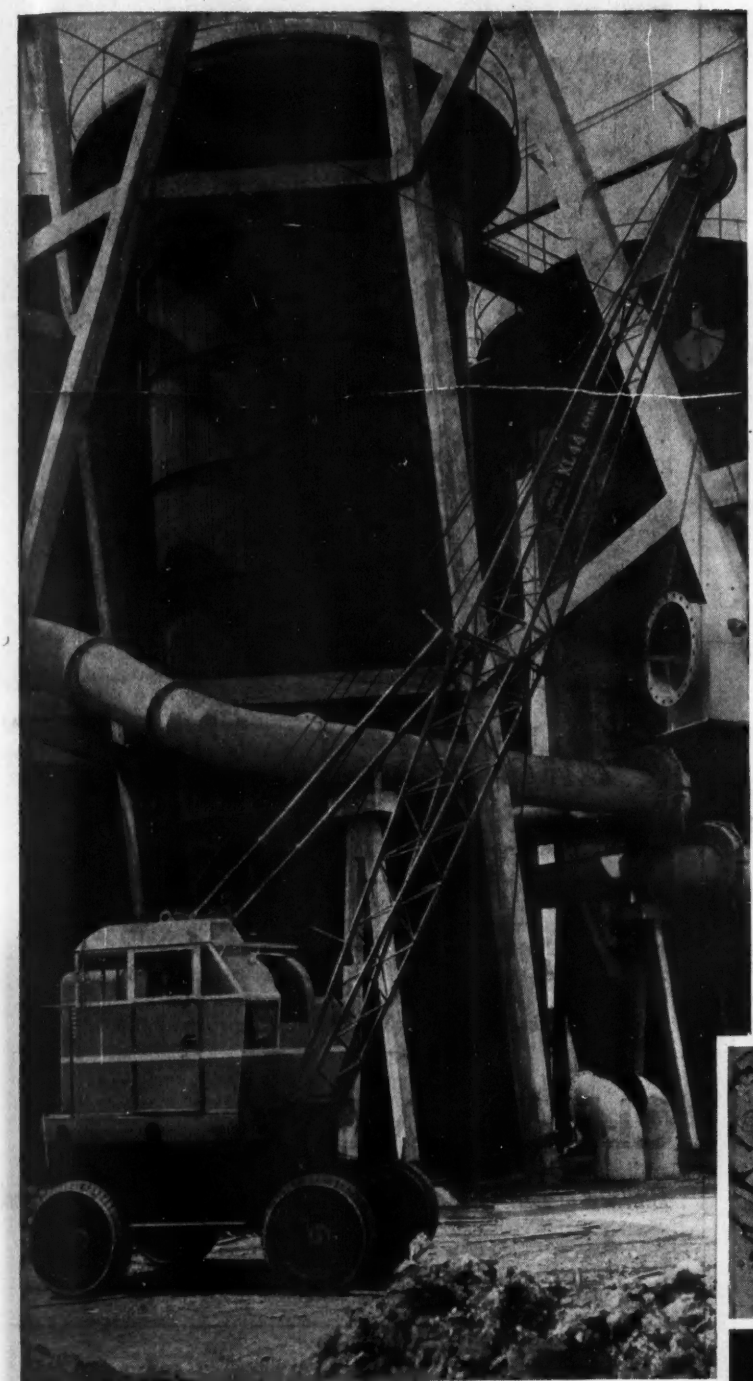

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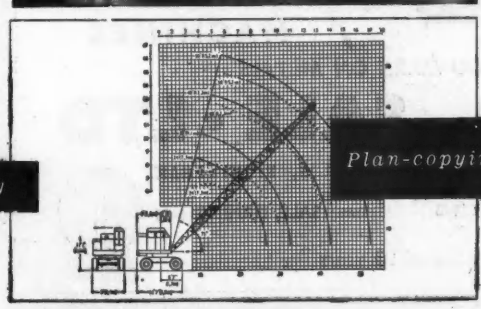

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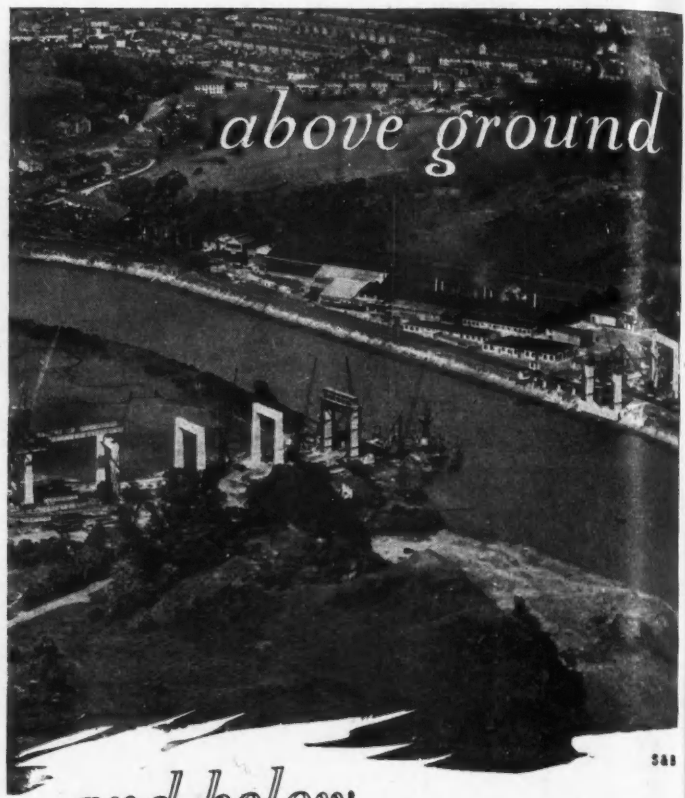

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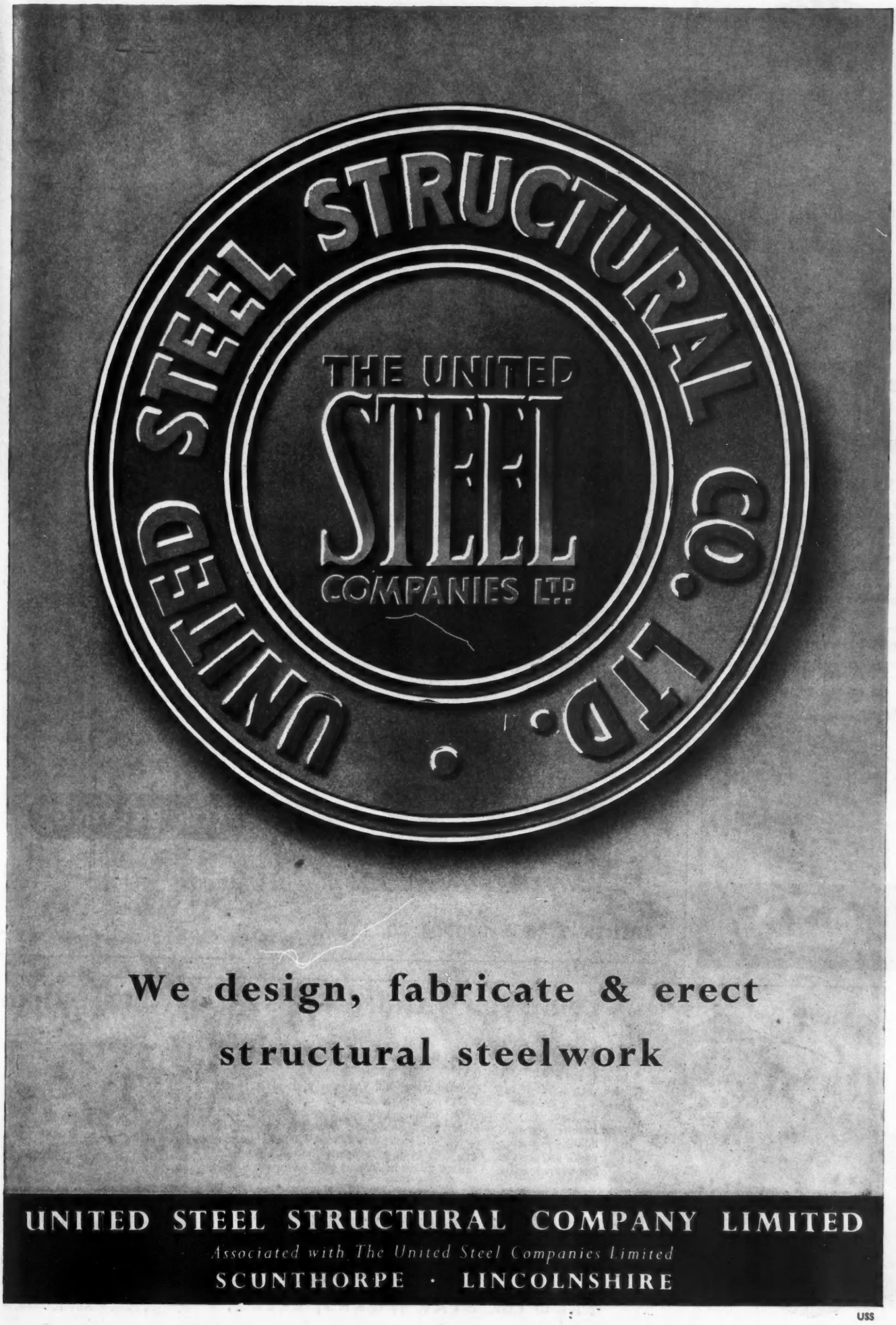
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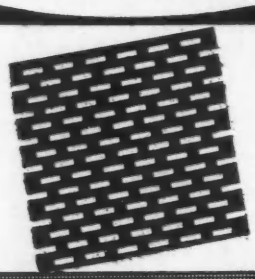

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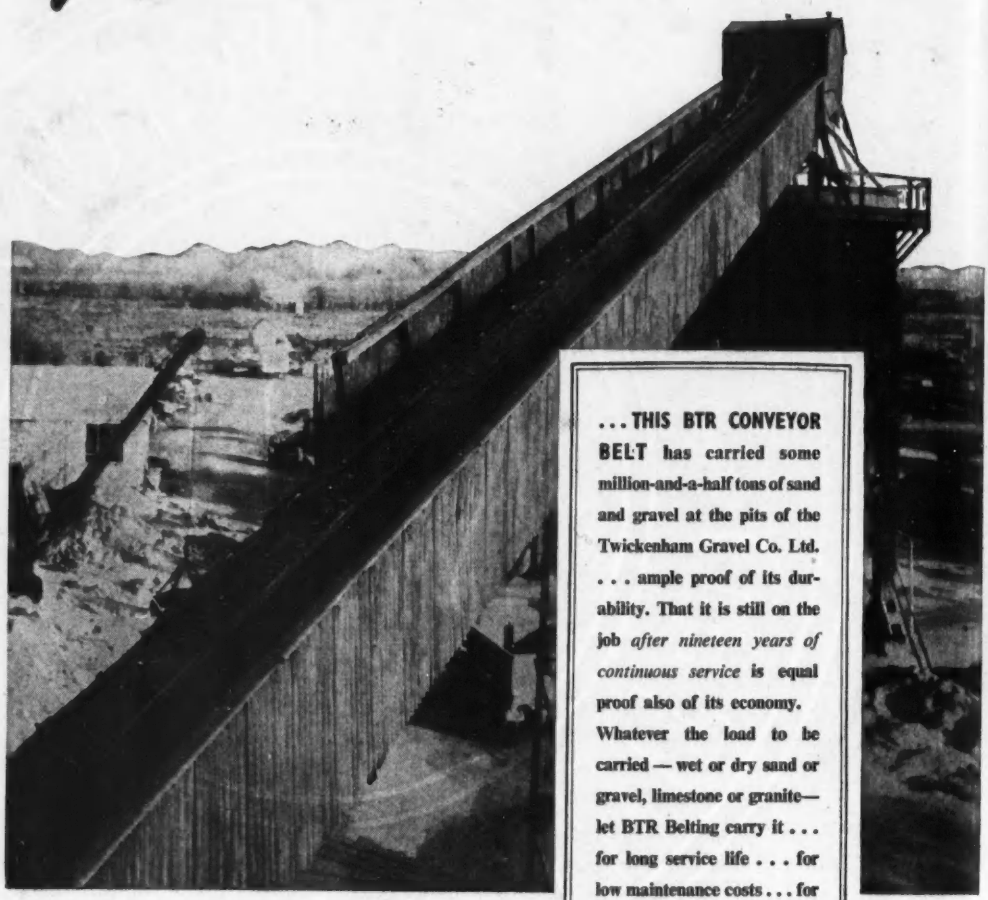

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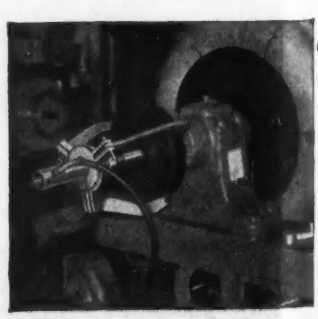

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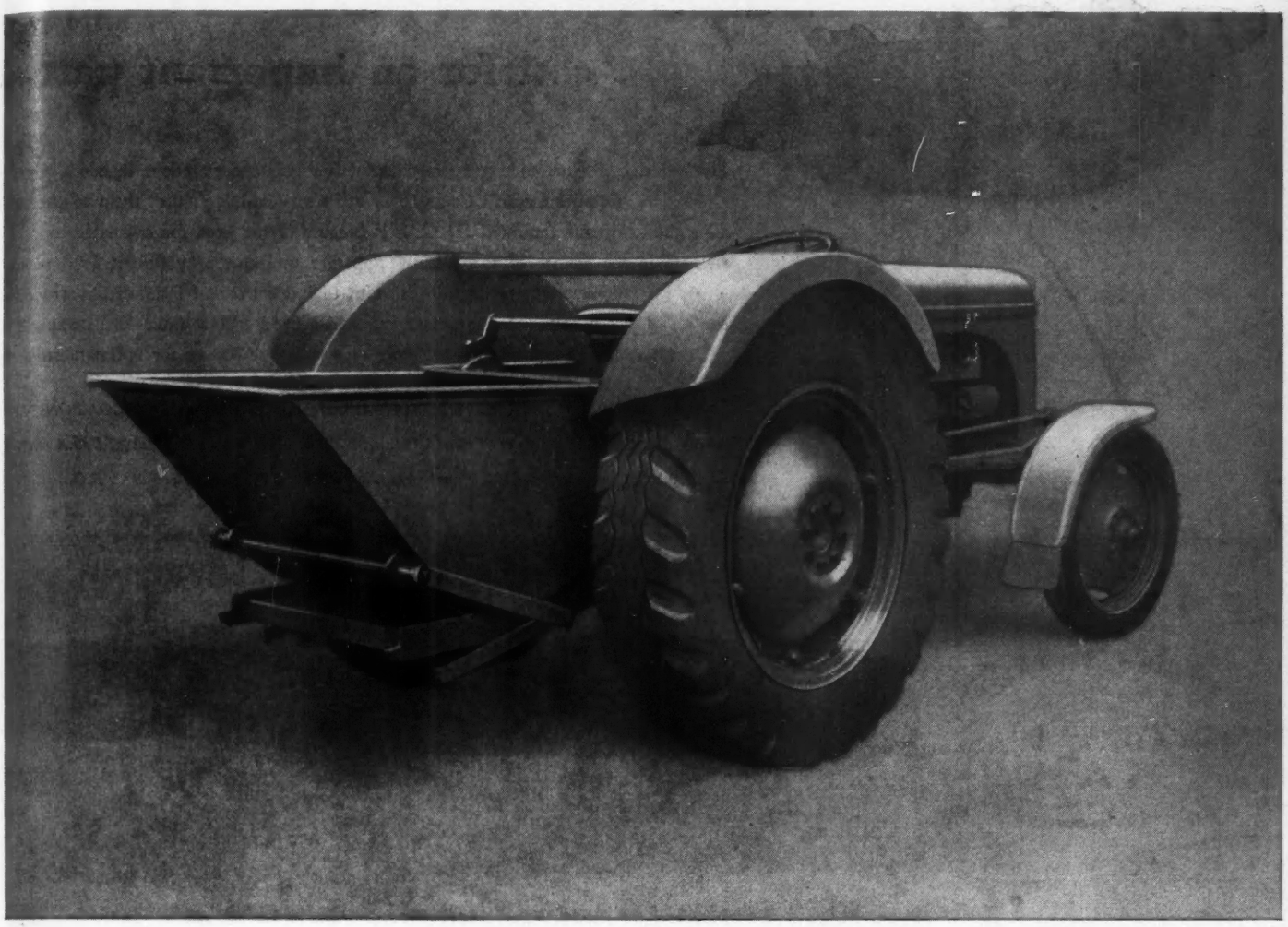

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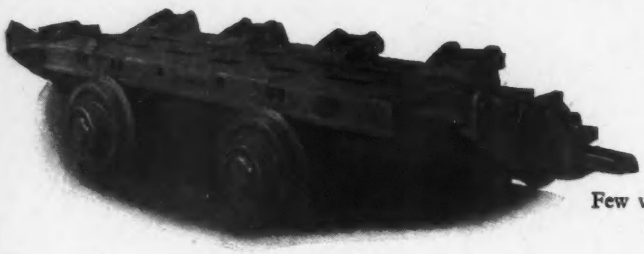

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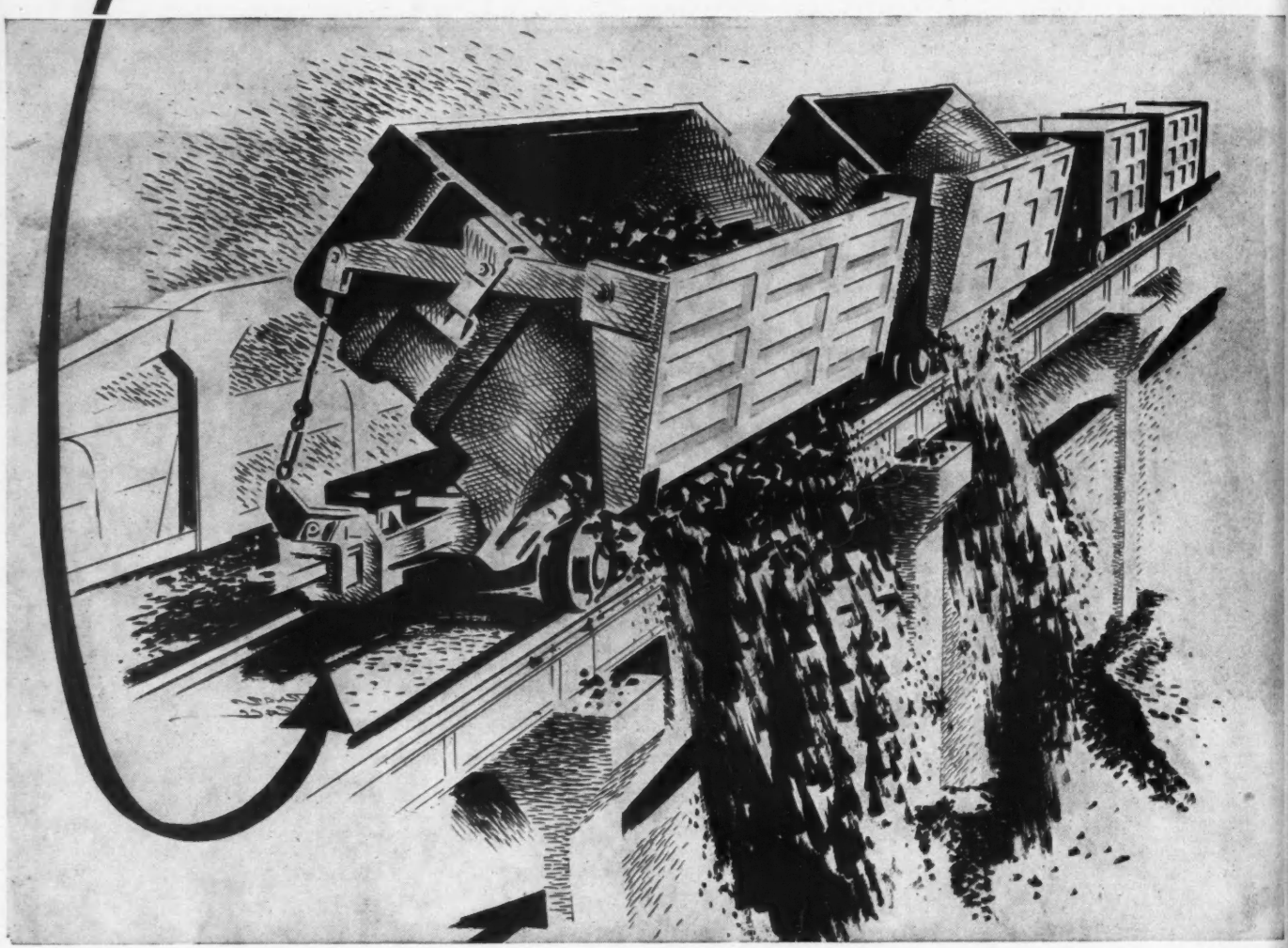

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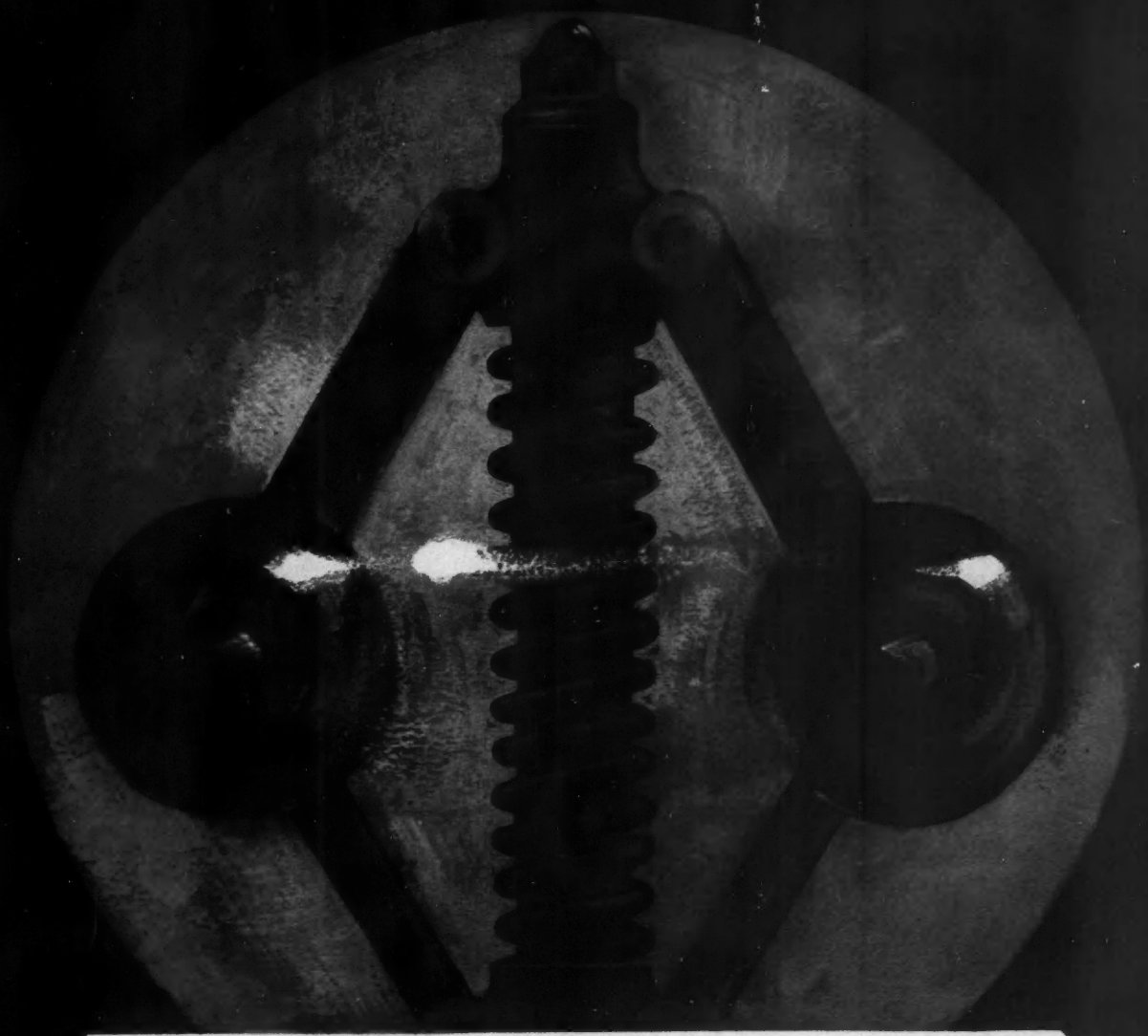

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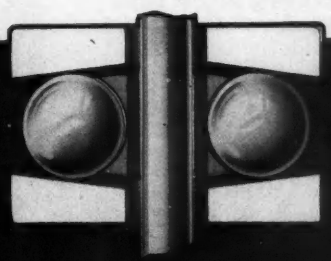

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Moulded by Ashdowns Ltd. from BAKELITE *rubber modified phenolic material X17181/1*

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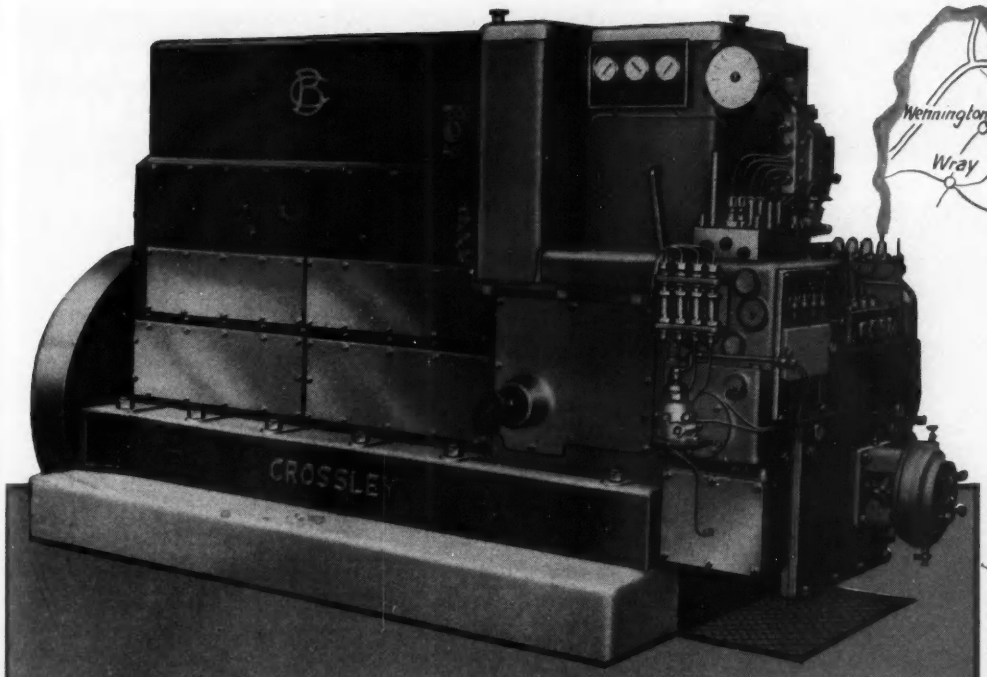

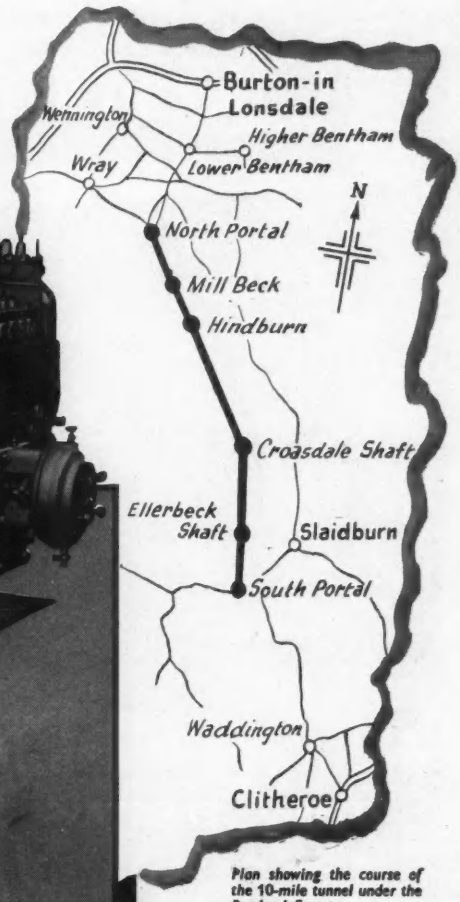

Plan showing the course of the 10-mile tunnel under the Bowland Forest.

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Thirlmere and Haweswater, connected by a new 73 miles long aqueduct, now ensure an increased water supply to Manchester. Part of the final stages of the scheme called for the boring of a tunnel 10 miles long under Bowland Forest.

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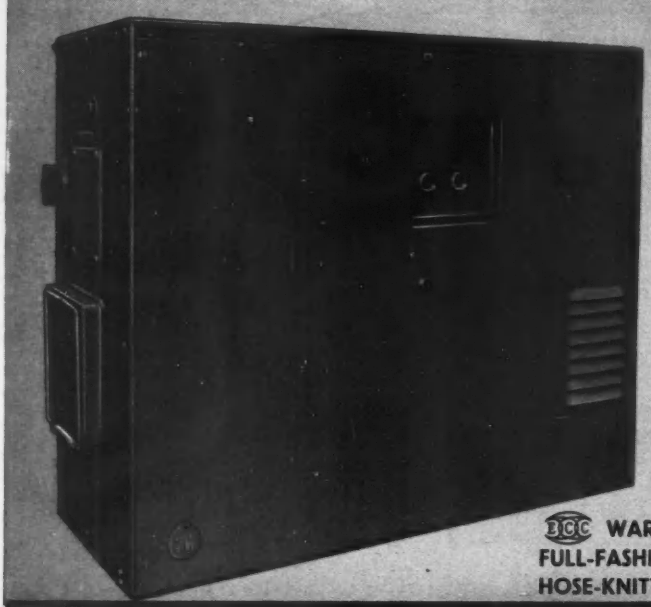

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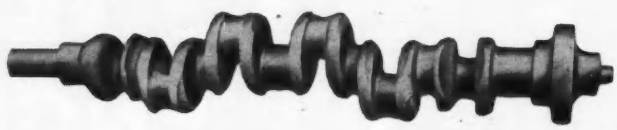

In the manufacture of engines for heavy road transport vehicles MASSEY Forging Plant is used for the production of high precision forgings. The photograph shows a large MASSEY Bridge Type Drop Hammer producing engine crankshaft forgings at Messrs. Smith-Clayton Forge Ltd., Lincoln. These MASSEY Drop Hammers are made in a range of sizes from 10 cwt. to 16 tons capacity, and produce forgings of the most intricate type at high production speeds. Their ease of control and adaptability, added to considerable economy in running and upkeep costs, make them essential in any general forge.

Full details of MASSEY Forging and Drop Forging Plant will be forwarded upon request.

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Photographs by courtesy of Messrs. Smith-Clayton Forge Ltd. Lincoln.

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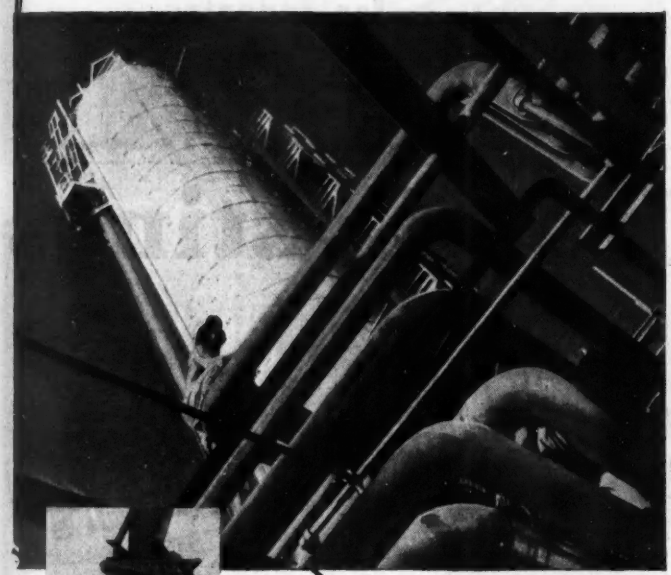
MAKERS OF THE WORLD'S GREATEST RANGE OF FORGING PLANT

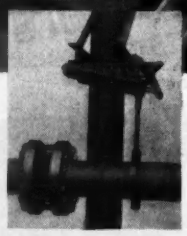
Photograph by courtesy of The Associated Ethyl Company Limited.

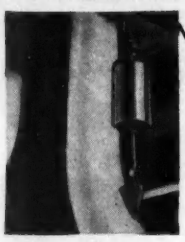
Two typical VOKES GENSPRING hanger installations in the oil industry

IN ADEN, The British Petroleum Company's new refinery came on stream in July 1954. Many sections of this complicated process plant piping demand the finest and most accurate suspension methods, and this requirement has been met by the installation of Vokes Genspring Variable Support Hangers. The Associated Ethyl Company Limited have also made use of these Vokes Genspring Hangers at their Ellesmere Port Works in Cheshire.



Photograph by courtesy of The British Petroleum Company Limited.





VOKES GENSPRING Variable Support Hangers are specifically designed for the control of vibration and limited thermal movement of piping, but where piping systems need to be 'floated' to offset the effects of extensive movement, Vokes Genspring Constant Support Hangers should be used. The full range is detailed in the Vokes Genspring catalogues available on request.

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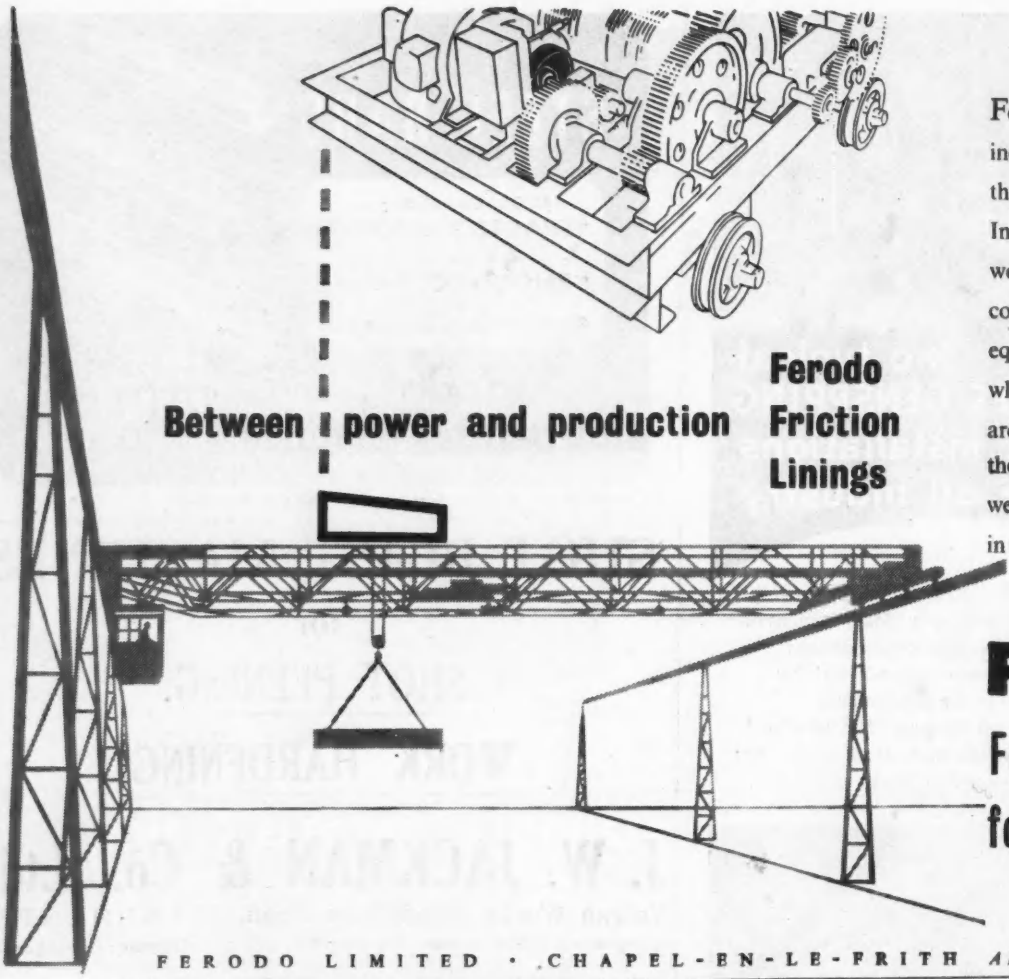

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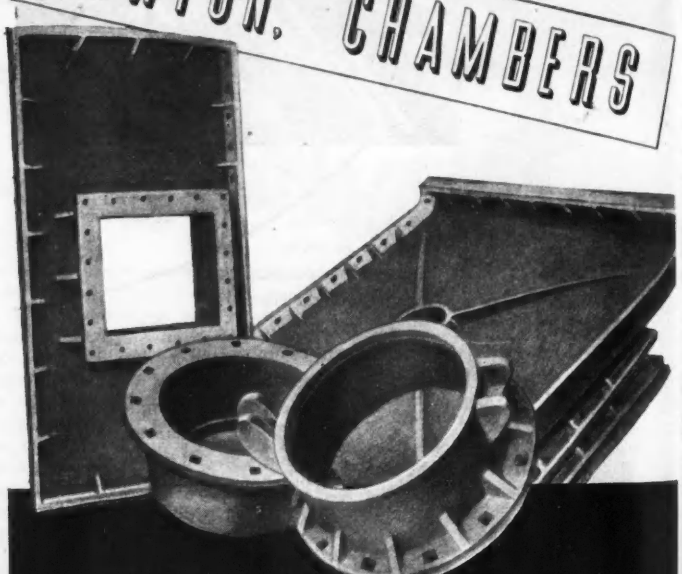

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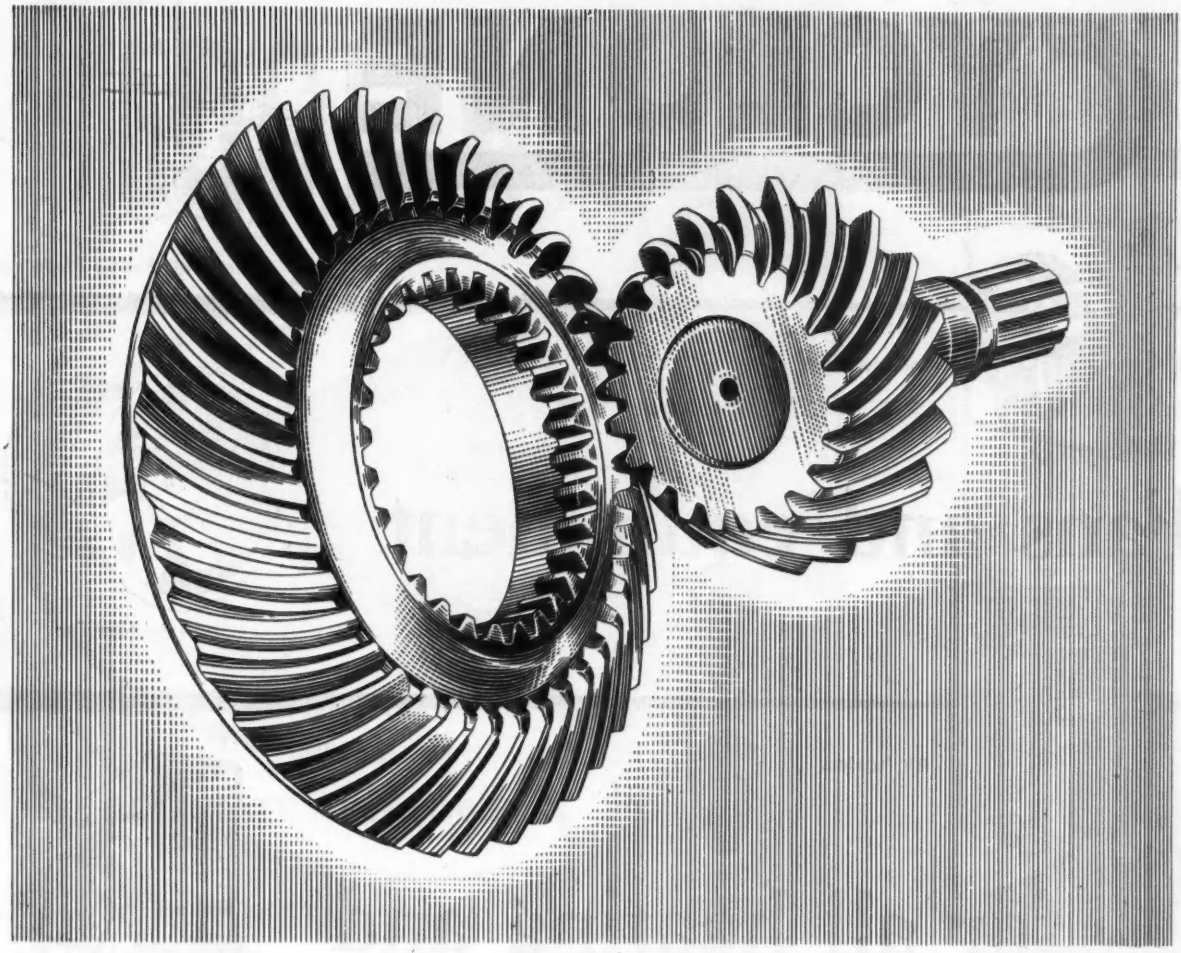

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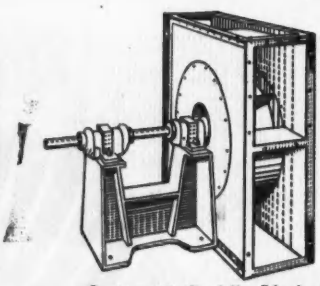
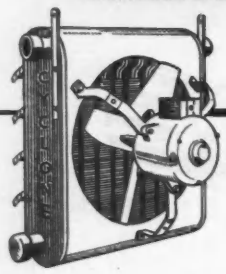
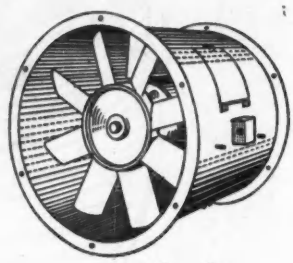


Series 4D Paddle Blade Fan

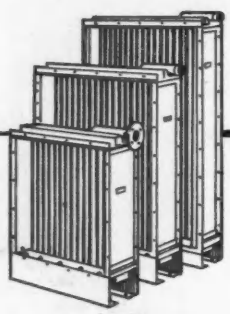


Unit Heater

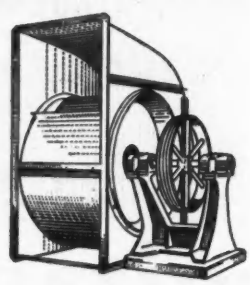


Axial Flow Fan

Fans and equipment



Air Heaters



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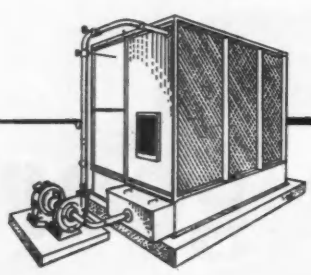
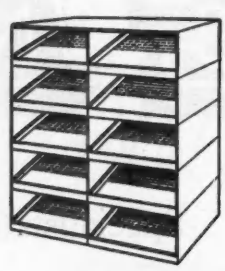


Air Washer



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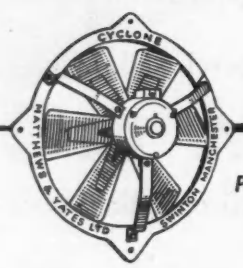

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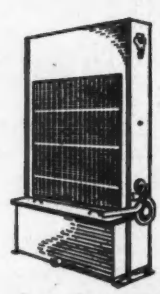

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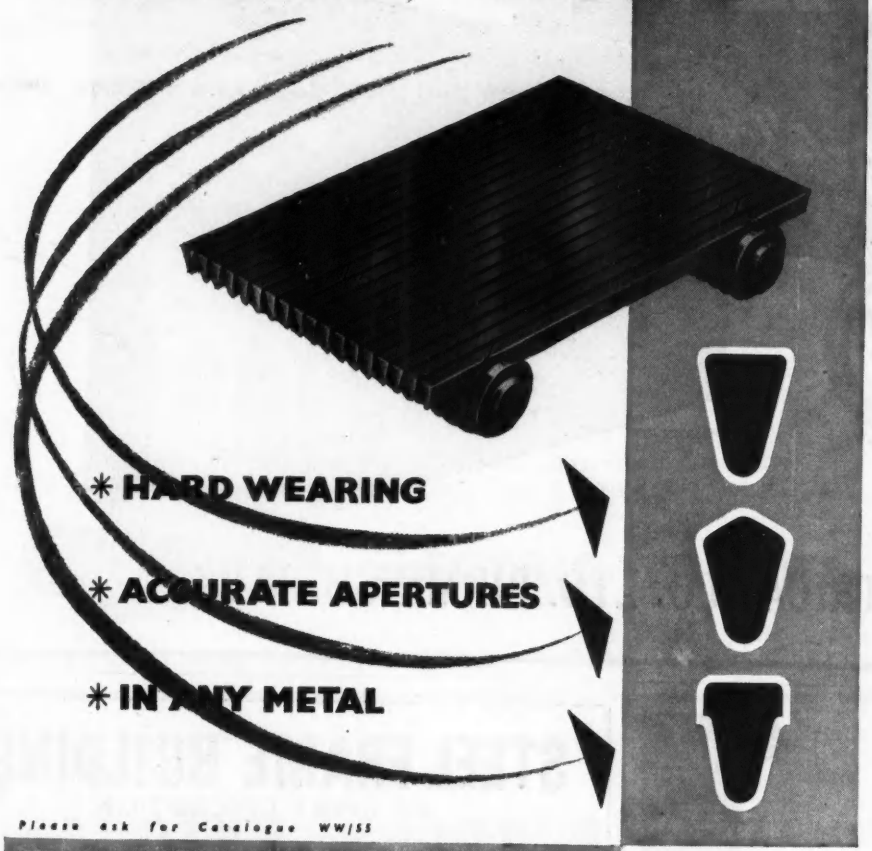

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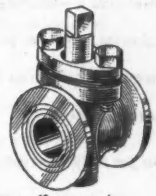

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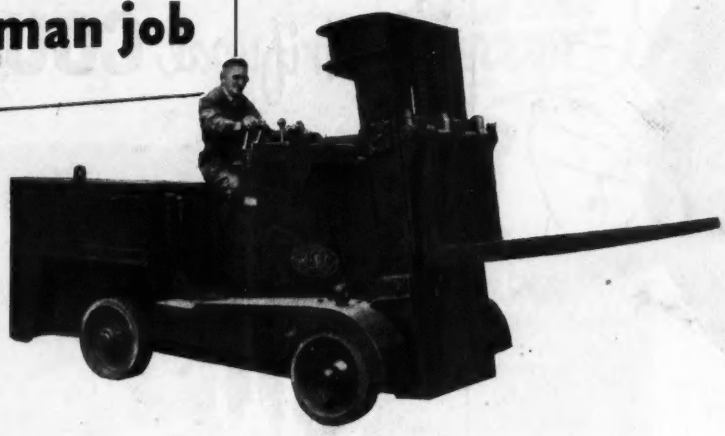

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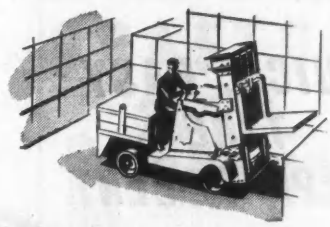

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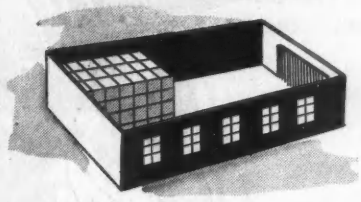

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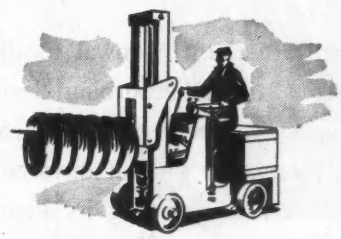

Different types are available to suit various applications. This model is for carrying and stacking coiled wire.

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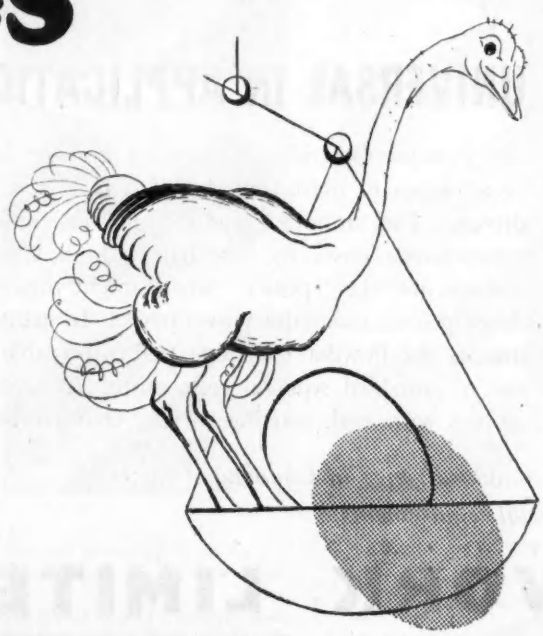

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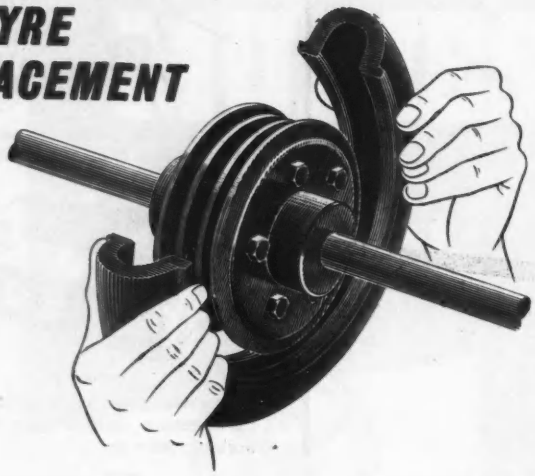

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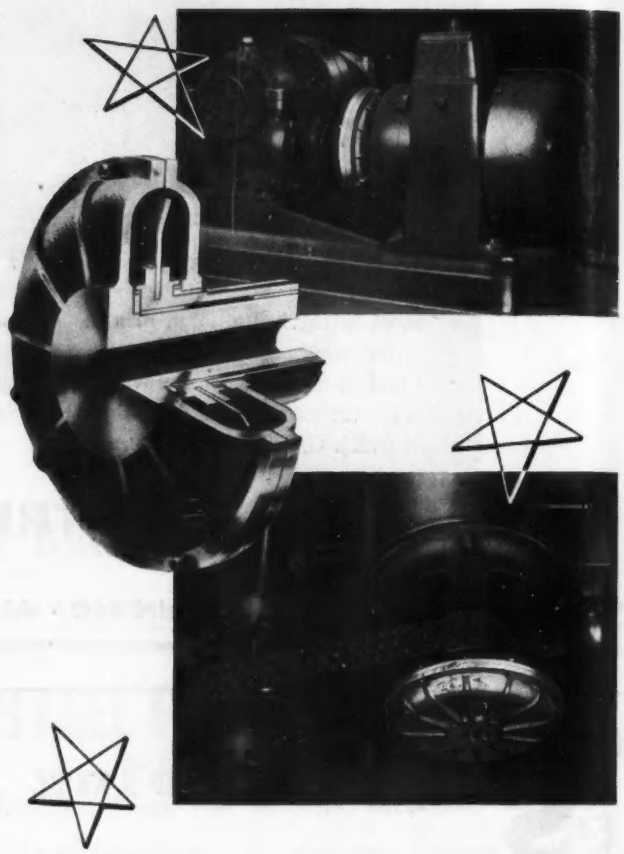

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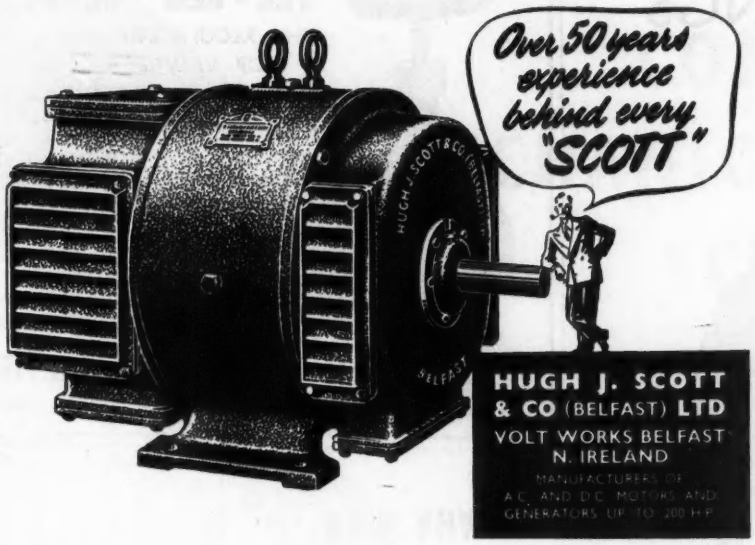
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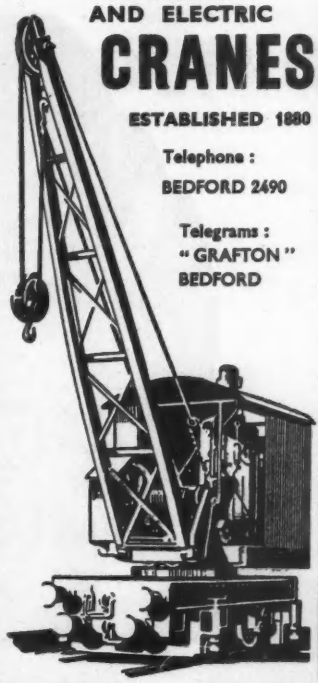
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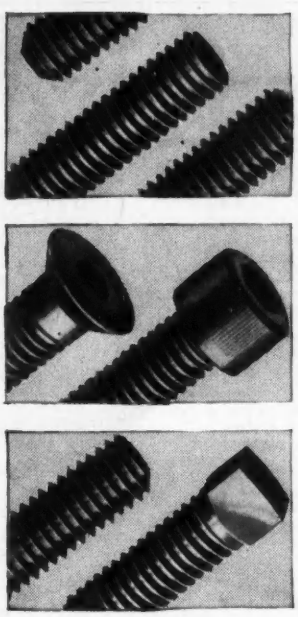

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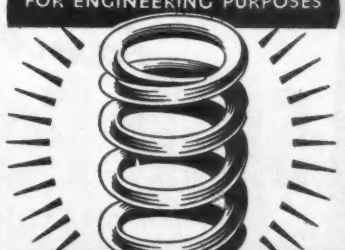
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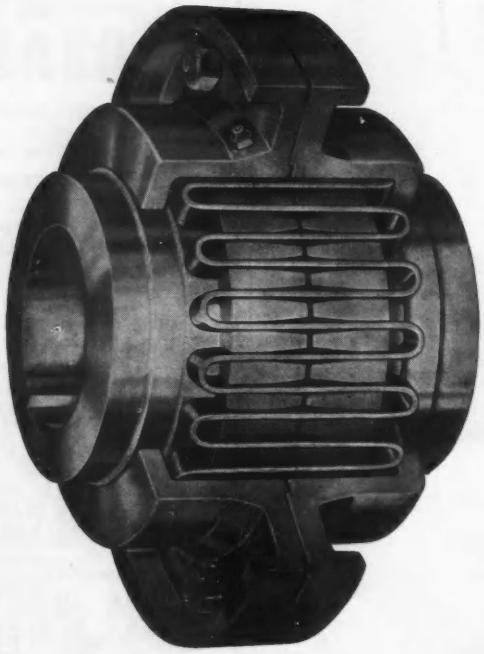

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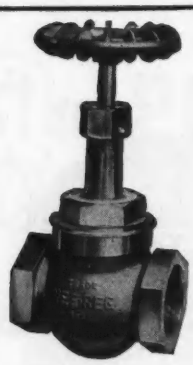

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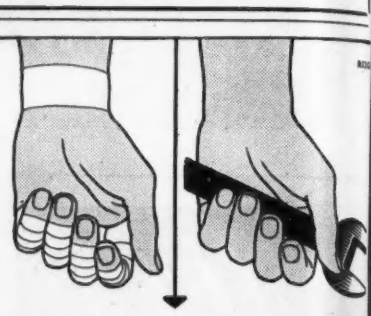

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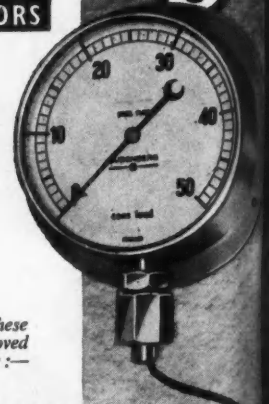

are now available for loads from 200 lb to 50 tons. The load cell is compact (for example, a 2 ton cell is only 2½" diameter) and is connected by flexible tubing to a suitably graduated Budenberg Pressure Gauge with 6" dial—other sizes by arrangement.

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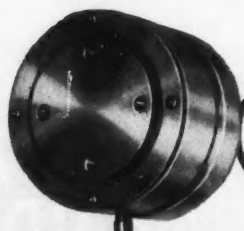
Accuracy of 1% can be obtained without difficulty provided that the load is applied centrally and at right angles to the plane of the cell.

Typical installations in which these load indicators have been proved successful are:—



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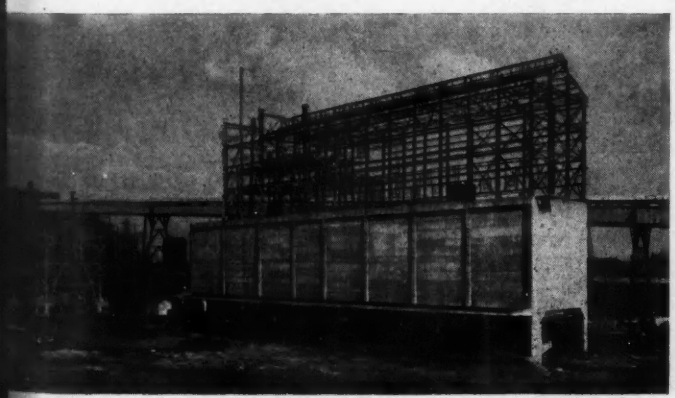

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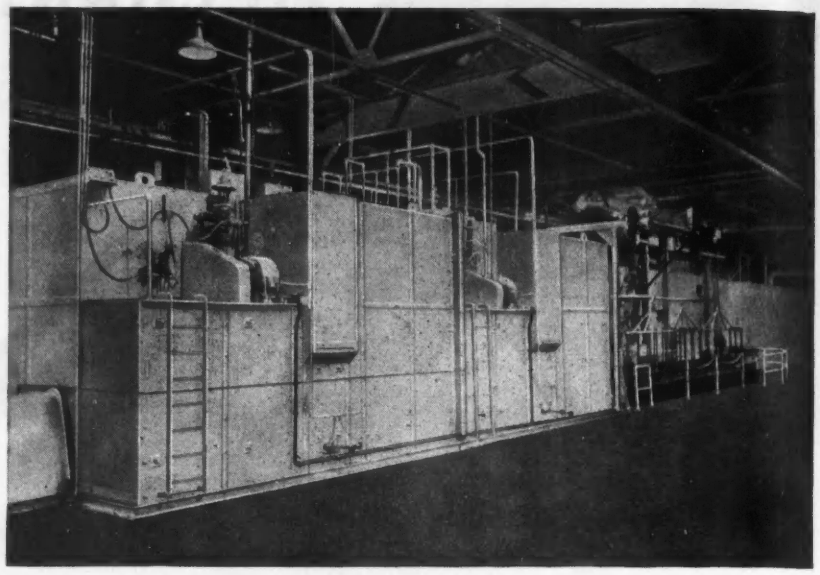

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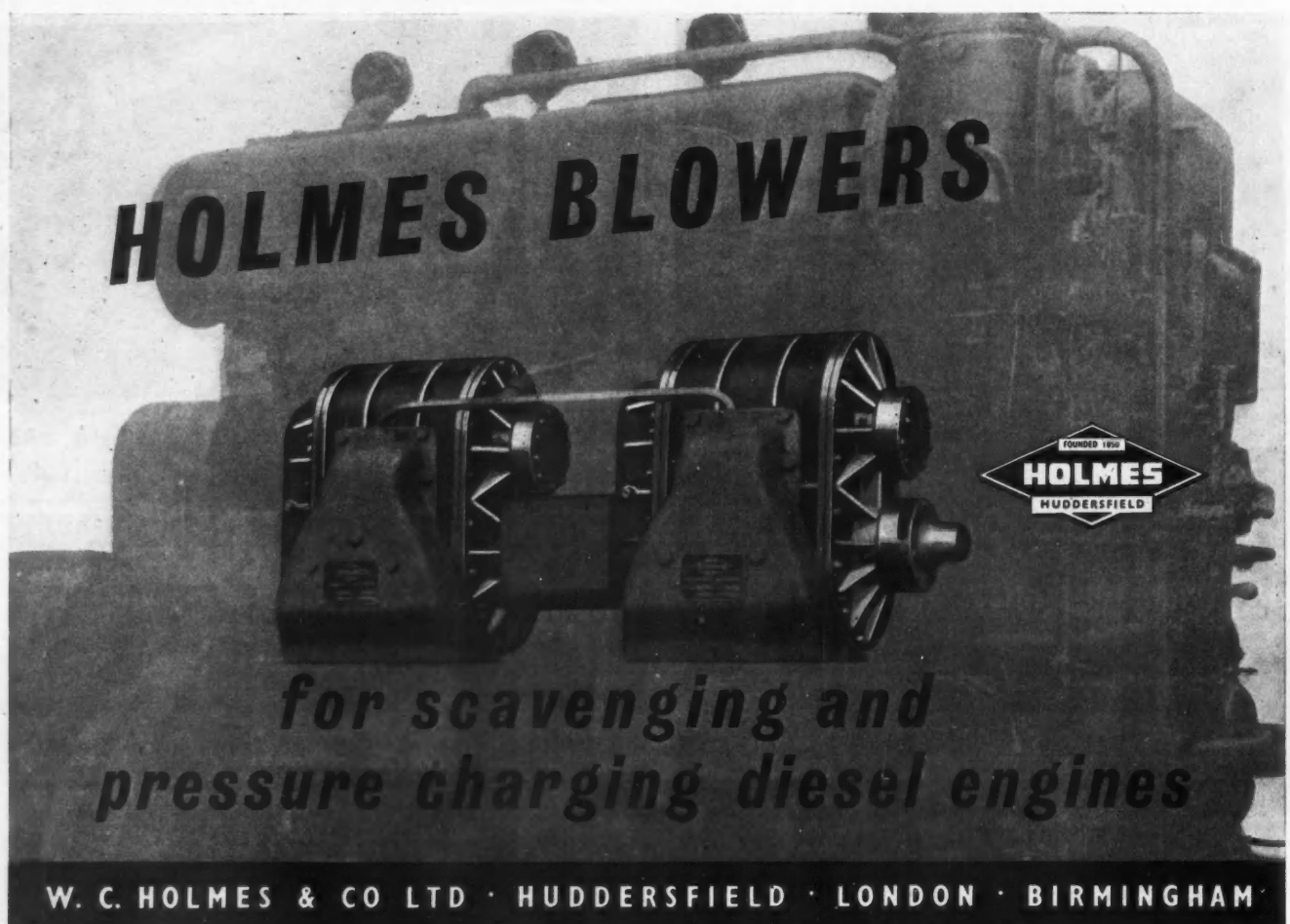


Owen Falls Many miles of power, distribution and control cables for the first section of this great scheme were supplied and installed for the Uganda Electricity Board by the BICC Group, who are also erecting 120 miles of 132kV overhead line to carry power to Tororo and Kampala.

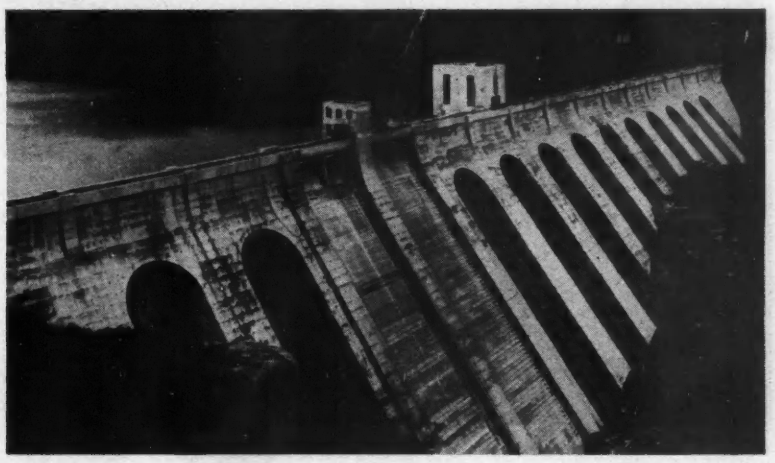
Consulting Engineers:
Sir Alexander Gibb & Partners and Messrs. Kennedy & Donkin.

3 Major Hydro-Electric Schemes

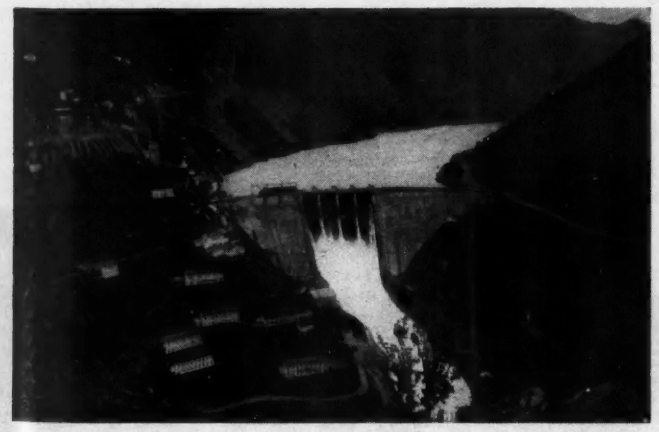
USING BICC TRANSMISSION EQUIPMENT

No two hydro-electric schemes are identical. Each presents a new set of problems to the transmission engineer, for terrain, climate and location are all important factors in the design, supply and installation of transmission equipment.

That is why BICC are so often employed on work of this nature. With their wide overseas representation, they have first hand knowledge of the difficulties likely to be encountered. Long experience and vast manufacturing resources enable them to supply and install hydro-electric transmission equipment anywhere in the World.



Loch Sloy This scheme is now connected with the Clachan power station of the Glen Shira Hydro-Electric Scheme by a nine mile single circuit 132kV overhead line. It was erected for the North of Scotland Hydro-Electric Board by the BICC Group. *Consulting Engineers:*
Messrs. Merz & McLellan of London.



Los Peares At Los Peares Spain, Fuerzas Electricas del Noroeste S.A. (Fenosa) have erected a dam and a 160,000kW power station. 2,000 ft. of BICC Mass-Impregnated Non-Draining multi-core control cables connect the power station with the switch station. They were supplied through our agents in Madrid, Dugopa S.L., to the British Thomson-Houston Co., Ltd.—main contractors.

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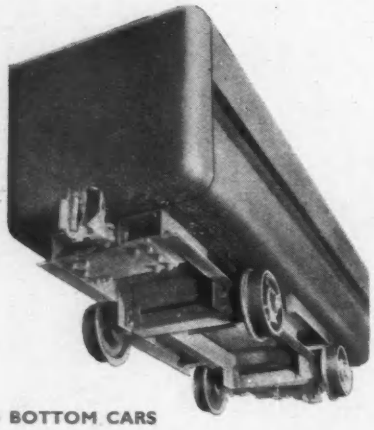
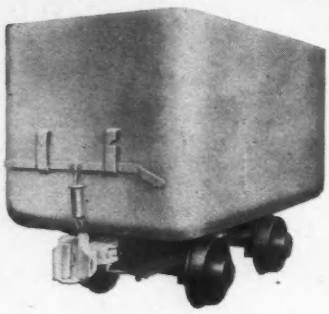
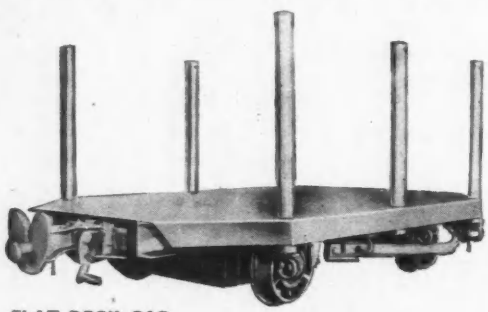


SOLID BOTTOM CARS





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LIGHT RAILWAY VEHICLES

Most Distington cars are made by flow production methods which include the extensive use of jigs; their components are therefore interchangeable; re-assembly of the cars is straightforward after they have been exported in 'knocked down' form. Cars required in small quantities, are built individually.

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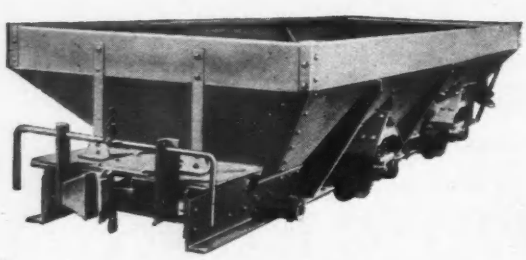
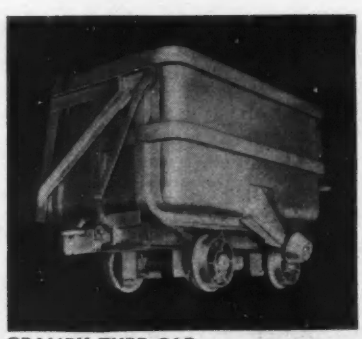
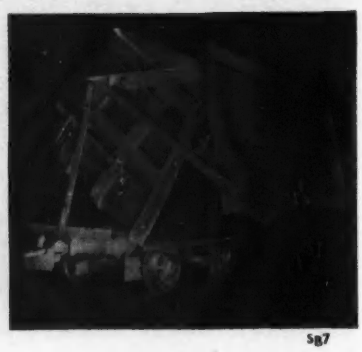


AUTOMATIC DROP-BOTTOM CAR

BOTTOM DUMP CAR

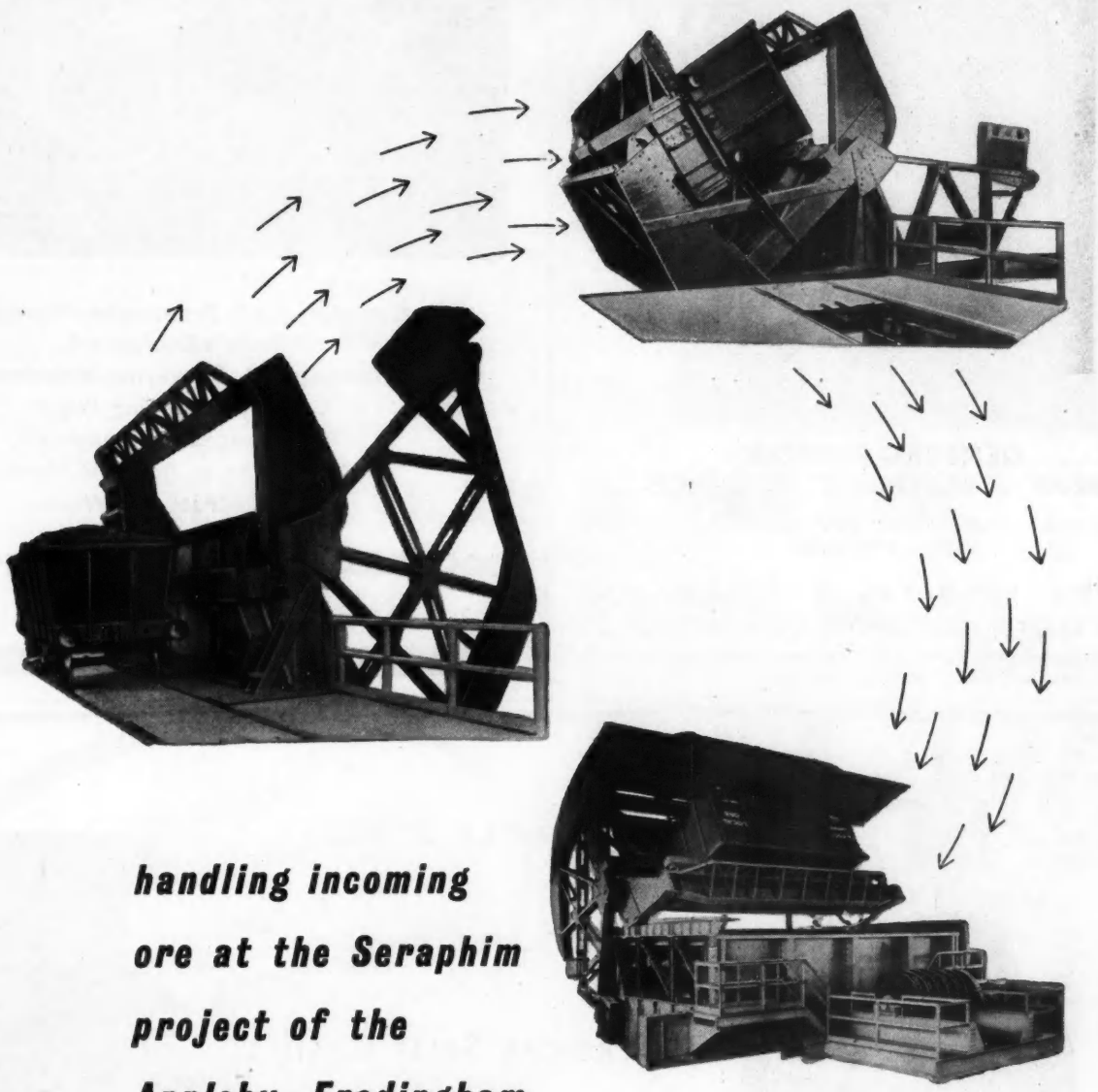


GRANBY TYPE CAR



587

wagon tippler...



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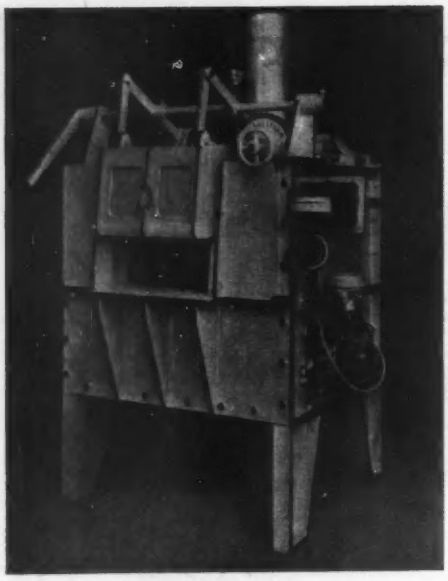

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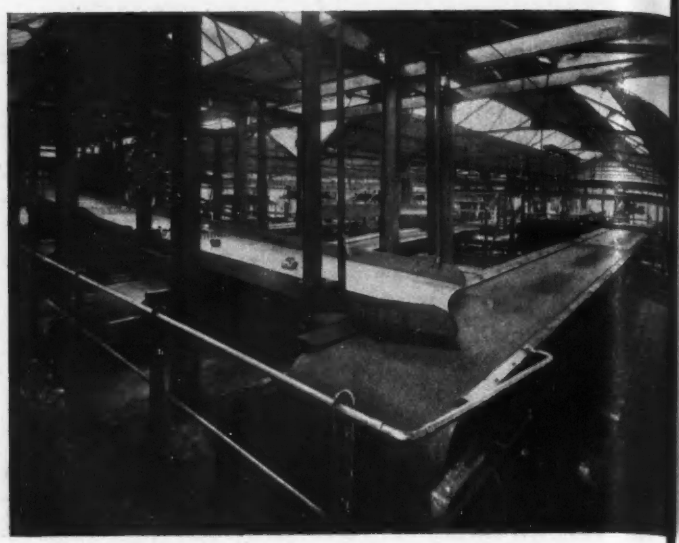

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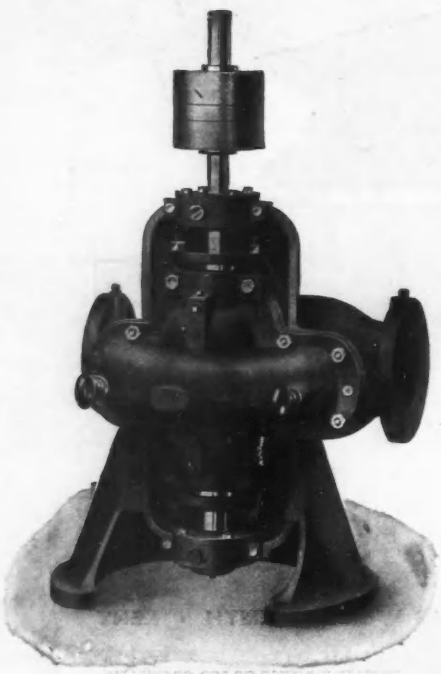

FIG. 4320
WITH EXTENDED SHAFT.

SINGLE-STAGE

DOUBLE-ENTRY

VERTICAL SPLIT-CASING

CENTRIFUGAL PUMPS

AS SUPPLIED TO
POWER STATIONS
FOR CIRCULATING DUTIES

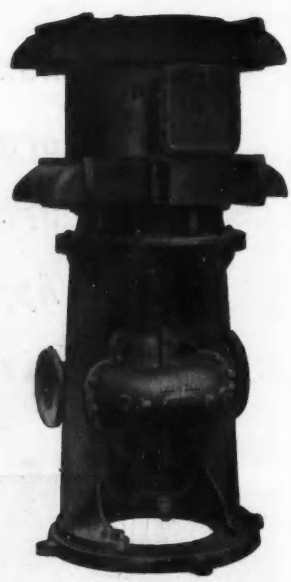

FIG. 4320 M
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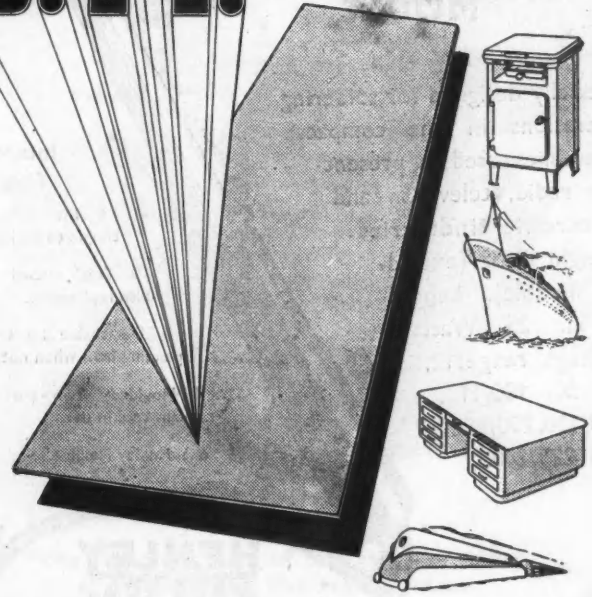
FOR ALL PURPOSES



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Specially designed for soldering operations in the compact assemblies used in present-day radio, television and electronic industries. Weight 3¼oz (excluding flexible). Length 9 in. 25 Watts Voltage range 12, 24, 50, 100/110, 120/130, 200/220 and 220/240.

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1 Bit $\frac{1}{16}$" diameter simple to replace.

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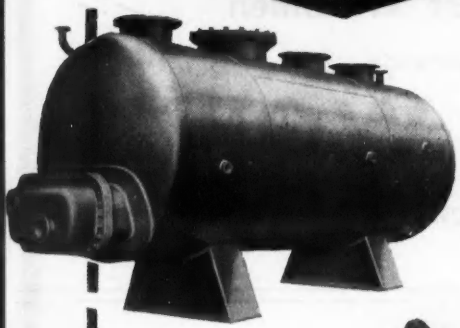

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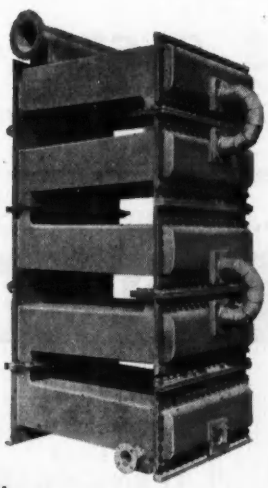

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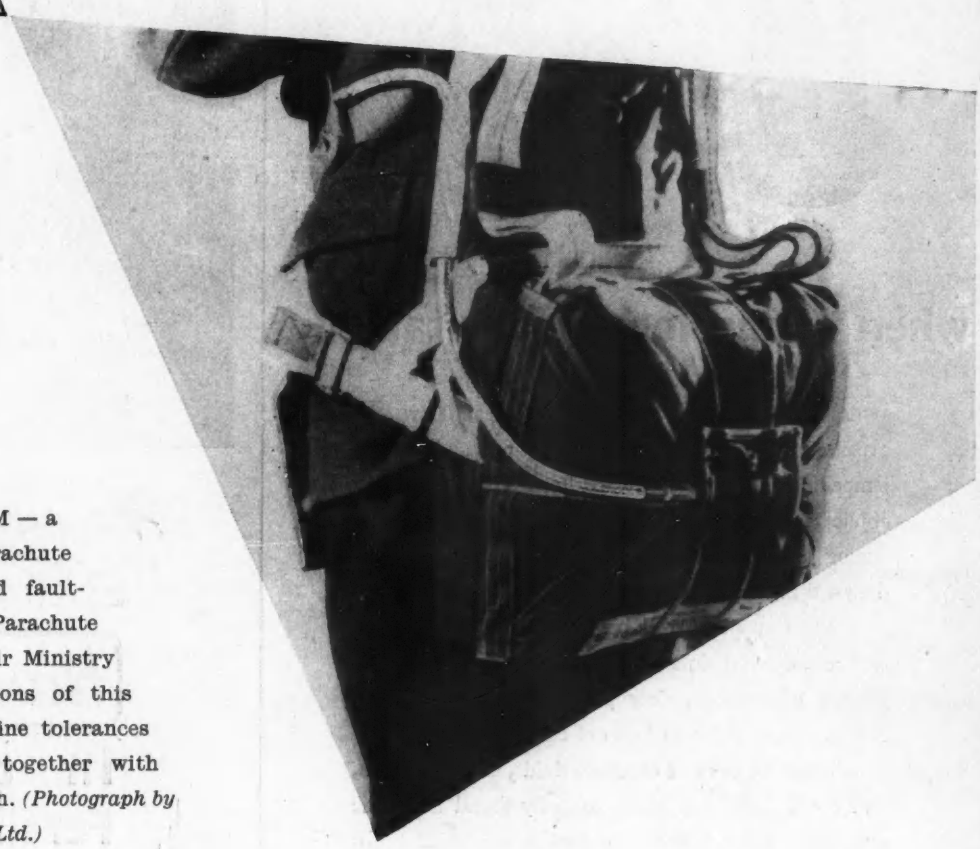

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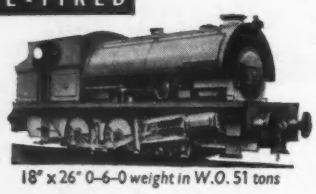

18" x 26" 0-6-0 weight in W.O. 51 tons

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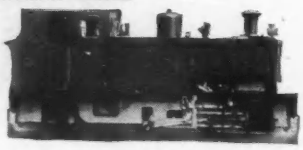

13" x 16" 0-4-2 weight in W.O. 29 tons

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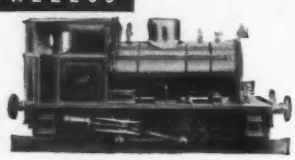

12" x 18" 0-4-0 weight in W.O. 18 tons

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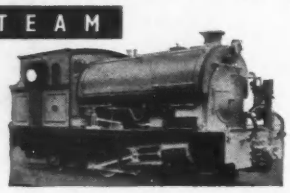

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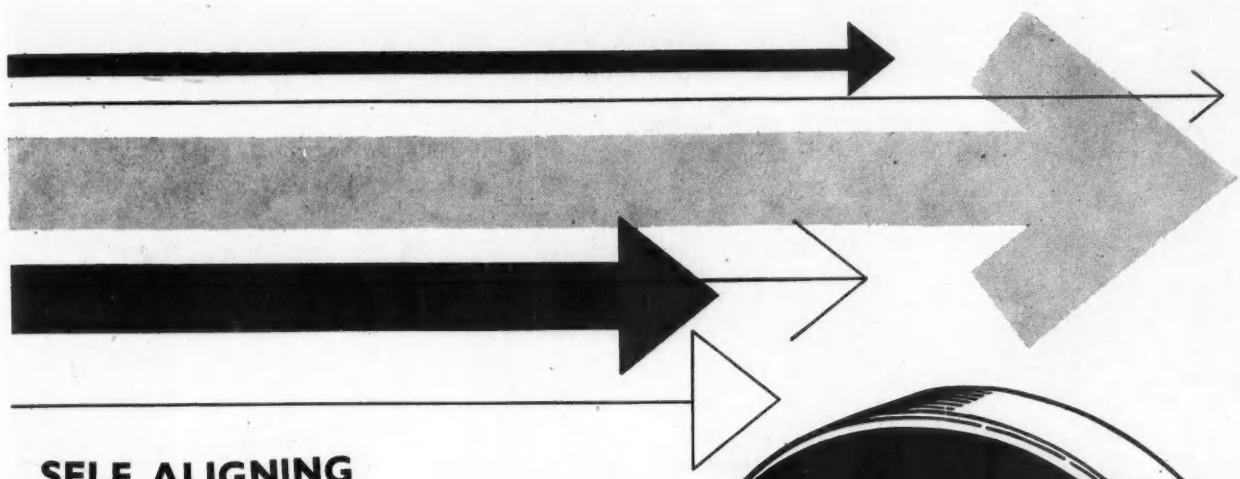

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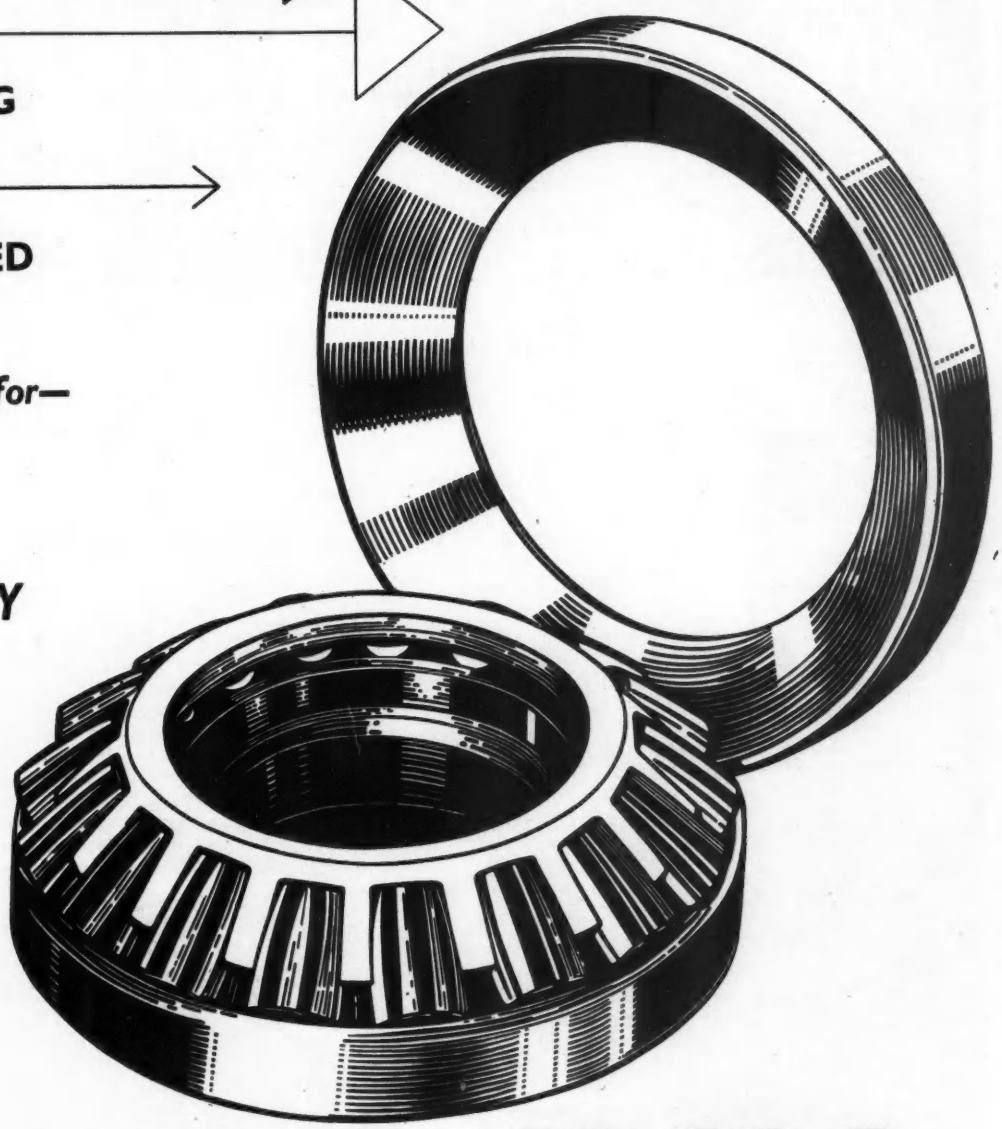

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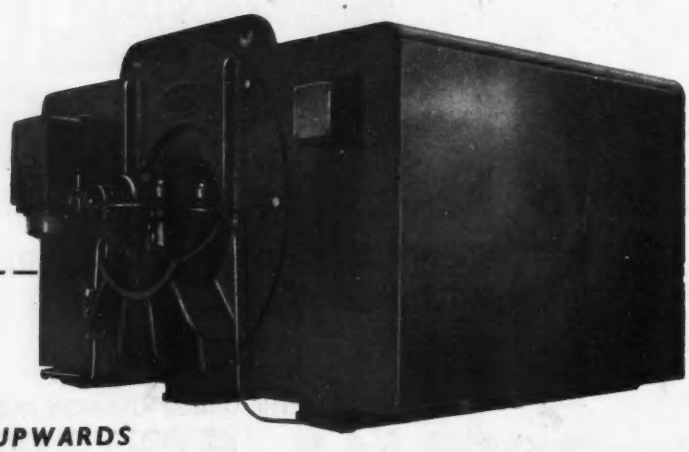

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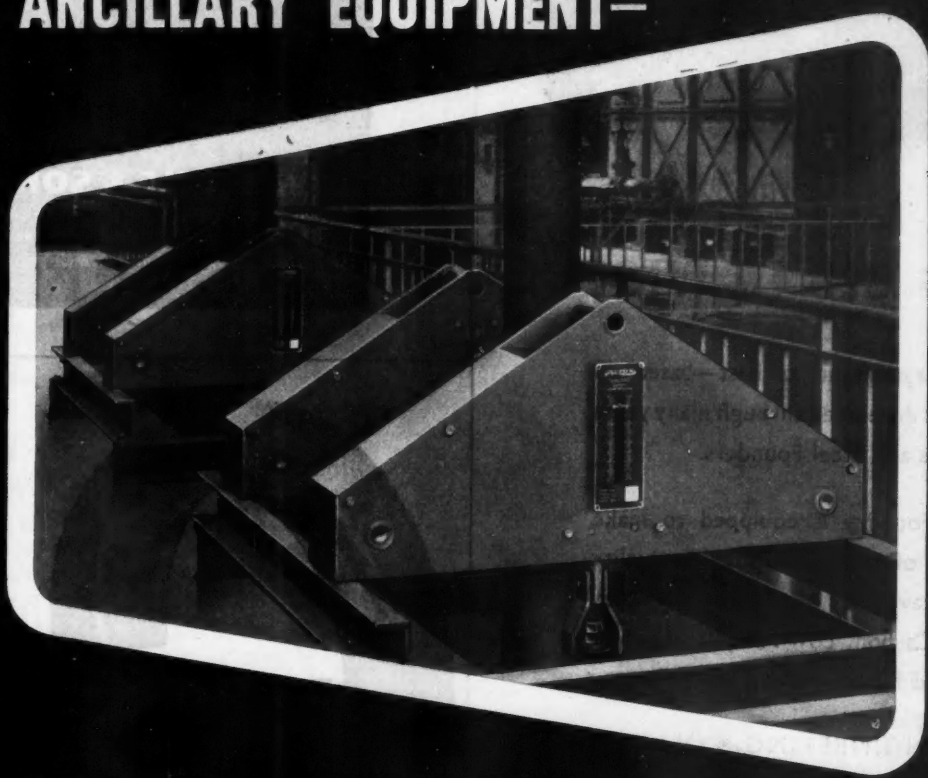

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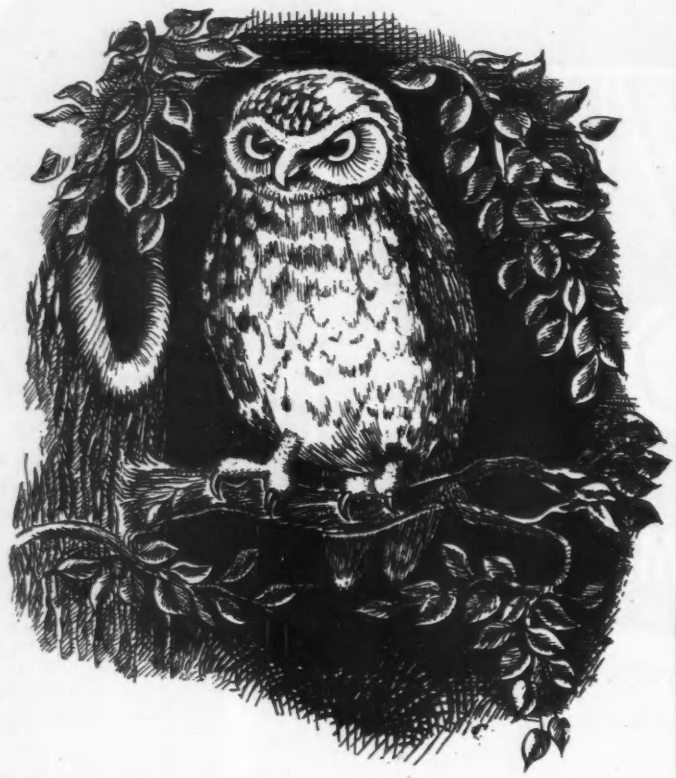

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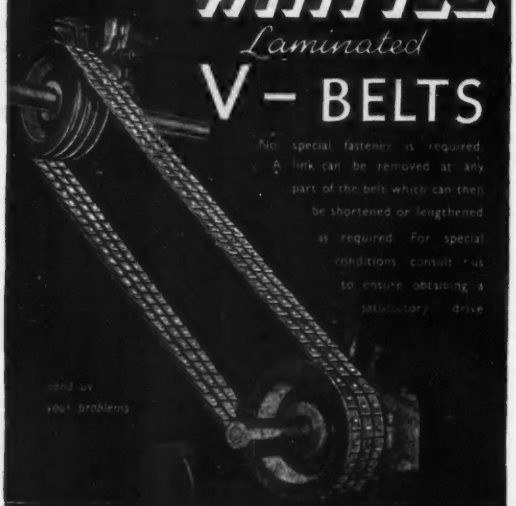

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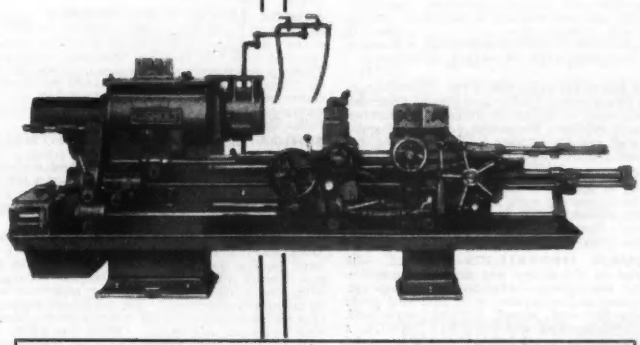

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Spindle bore - - - - in.	3 15/16	4 15/16	5 15/16
Speed range (12) - - r.p.m.	20-486	12-333	12-333
H.P. motor 400/3/50 - - -	10	10	16

*Some with cross sliding turret.

All for chuck work and well equipped.

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SITUATIONS VACANT

NOTIFICATION OF VACANCIES ORDER, 1952

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18–64 inclusive or a woman aged 18–59 inclusive, unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order, 1952.

MECHANICAL ENGINEERS, experienced in oil/chemical industries and mechanical bulk handling, required for various sites in the British Isles. Permanent and progressive positions offered to suitable applicants. Salary according to qualifications plus out-living allowance.—Write, giving full details, to George Wimpey and Co., Limited, Department 1/Mechanical, 27, Hammersmith Grove, London, W.6. E5256 A

MECHANICAL HANDLING DRAUGHTSMEN required for projects office with experience of conveyors and ancillary equipment for power stations, steelworks and industrial undertakings. Good salary. Pension fund, canteen, &c.—Moxey Conveyor and Transporter Company, Ltd., 15, Augustus Road, Birmingham, 15. E5316 A

METHODS ENGINEER required by toolmakers specialising in moulds for the plastics industry. Versatile man able to introduce new ideas into the toolroom. Pension scheme and good working conditions.—Applications to BOX No. 218, R. Anderson and Co., 14, William IV Street, London, W.C.2. E5228 A

METHOD STUDY ENGINEER required for engineering department of large progressive batch type production factory. Applicants should be 27 to 35 years of age, with engineering training and technical education to H.N.C. standard, and preferably trained in motion study practice. The job, which is of wide scope and varied nature, involves working as a member of a team engaged upon problems concerning the expansion and improvement of factory production plant. The post is a permanent senior staff appointment, and a contributory pension scheme is in operation.—Applications, stating age, training, experience, salary required, &c., and quoting reference E/MSE.4, to Personnel Manager, Ferodo, Limited, Chapel-en-le-Frith, Via Stockport. E5319 A

MONSANTO CHEMICALS, LIMITED, Newport, Mon., have vacancies for Senior Mechanical Engineering Draughtsmen. Preference given to men having experience in the chemical, petroleum or allied industries who are able to write specifications, issue inquiries, design and produce drawings of piping systems, pressure vessels and layouts. The posts are permanent with good prospects and pension scheme.—Apply in writing, stating age, experience, technical qualifications and salary expected, to Personnel Manager, Monsanto Chemicals, Limited, Corporation Road, Newport, Mon. E736 A

MONSANTO CHEMICALS, LIMITED, London, have vacancies for Draughtsmen having experience in plant layout, piping, vessel, electrical and instrumentation work. The posts are permanent and pensionable and good salaries, according to experience, are offered. Five-day week and lunch voucher scheme are in operation.—Applications in writing, giving full details of age, training and experience, should be sent to the Chief Personnel Officer, Monsanto Chemicals, Limited, 8, Waterloo Place, London, S.W.1. E744 A

MONSANTO CHEMICALS, LIMITED, require the services of an Estimator with some experience in estimating in the chemical or petroleum fields on electrical installations, power, lighting, distribution relays, electrical controls and/or some experience of estimating for instrumentation—this would include control rooms, all the conventional type instruments, panels, pneumatic controls, &c.—Applicants should send full particulars of their age, training, qualifications and experience, to the Chief Personnel Officer, Monsanto Chemicals, Limited, 8, Waterloo Place, London, S.W.1. E5391 A

NON-FERROUS FOUNDRY MANAGER (Directorship later) required, preferably experienced technically and commercially in centrifugal casting. Exceptional remuneration and an interest in financial results.—Apply in confidence, Chairman, Metals and Alloys, Ltd., Minworth, Birmingham. E2344 A

PETER BROTHERHOOD, LTD., Peterborough, require Draughtsmen (senior and junior), preferably with experience in design of compressors, turbines and steam engines. Permanent positions, five-day week, staff pension scheme. — Write, giving full details age, experience and salary required. E342 A

PIPING DRAUGHTSMAN required, experience of piping as applied to oil refineries and chemical plants for interesting work in London. Salary £14 per week upwards, plus a liberal London living allowance. Please apply giving full particulars to—BOX No. E5441, "The Engineer." A

PRECISION HYDRAULICS.—Engineer, with knowledge of the theory and design of precision hydraulic mechanisms.—Applications, stating age, qualifications and experience, to be addressed to the Secretary, Barr and Stroud, Limited, Anniesland, Glasgow, W.3, quoting ref. 769/T–15. E5232 A

PRODUCTION MANAGER required for large expanding Engineering Company situated in the Home Counties, specialising in the production of castings, machine shop components and assemblies, forgings and stampings. This position requires a man of initiative, fully experienced on modern methods of production and material handling, planning and loading.—Please state full details of experience to BOX No. E2328, "The Engineer." A

REINFORCED CONCRETE DESIGNERS/DETAILERS wanted by British company in Mombasa (Kenya), Kampala (Uganda) and Dar-es-Salaam (Tanganyika). Candidates should have had at least five years' experience. Salary according to ability and experience. Free air passages, two months' paid home leave by air each 2½ years, bonus and pension schemes. Applications will be treated in strict confidence.—Write, BOX "R13/4/55," c/o 95, Bishopsgate, E.C.2. E732 A

RESEARCH ENGINEER required for the Mechanical Engineering Section of a Metallurgical Laboratory, to undertake research work of a wide nature. Qualifications should be a Degree in Engineering or Corporate Membership of a recognised Institution, with experience, if possible, in fatigue and creep of metals. Salary up to £850 per annum.—Apply, giving age, full details of education and experience, to the Director of Research, Fulmer Research Institute, Ltd., Stoke Poges, Bucks. E2280 A

Positions available for
PROJECT ENGINEERS
at the
KELLOGG INTERNATIONAL CORPORATION . . . positions with the career potential only a top-ranking firm can offer.

The men who fill them will be the "job architects" supplying the technical information required for design and development of oil refineries and chemical plants . . . lending their extensive experience to every phase of the project . . . and maintaining considerable liaison work with the customer.

A Degree in Chemical or Mechanical Engineering with 8–10 years' diversified experience in the petroleum and chemical industries are minimum requirements. The right men for the job will know the others, in terms of initiative, ability and personality.

Interested persons should send complete details, including salary requirements, to the
Personnel Manager,
Dept. 26/G,
Kellogg International Corporation,
7–8, Chandos Street,
London, W.1.
E5273 A

RESIDENT ENGINEER required, Central London area, by firm of specialist heating contractors. Must have tact in working with other contractors and capable of controlling labour, progressing drawings and materials. Duration of contract 12–18 months.—Write giving details of age and experience to Box T.E.633, c/o 191, Gresham House, E.C.2. E5522 A

ROWNTREE & CO., LTD., have several vacancies at York for senior draughtsmen. The positions to be filled require men who are either (a) experienced in general factory engineering and layout or (b) experienced in automatic wrapping machinery. All candidates must have technical and shop training, and higher National Certificate preferred. Working conditions, salary and holidays are good and the positions are pensionable. Intending candidates are invited to write to The Staff Officer (Men), Ref. A.D. Rowntree & Co., Ltd., The Cocoa Works, York, for official application form. E2337 A

SALES ENGINEER (MECHANICAL), single and under 28, with G.I.Mech.E., and good knowledge of diesels, required for Malaya by British company. Knowledge of contractors' or electrical plant an advantage. Six months' paid home leave on each contract, initially four years, with remuneration according to ability and experience. Pension scheme and provident fund.—BOX No. E5402, "The Engineer." A

SALES REPRESENTATIVE, to live in and work in Eastern Counties, required by large W. London light engineering company manufacturing specialised component to machinery builders' own designs. Applicants should have education to H.N.C. standard in Mech. Eng. Indentured apprenticeship desirable. Previous experience in engineering and sales essential. Starting salary £800/£1000 p.a. Expenses met and car provided.—Write, giving full particulars, to BOX No. U5323, A.K. Advg., 212a, Shaftesbury Avenue, London, W.C.2. E5384 A

SECTION LEADER MECHANICAL DRAUGHTSMEN and competent Detailers required by Ashmore, Benson, Pease and Co., Stockton-on-Tees. Experience in layout and design of gas, chemical and similar plants an advantage, otherwise sound knowledge mechanical design required. Pension scheme, technical library, sports facilities available also maximum assistance given in obtaining accommodation.—Apply stating age, experience, &c., quoting reference, "L," to Staff Personnel Officer. E715 A

SENIOR COST ESTIMATOR, with engineering background, required by Central London company. High salary rate for fully experienced man. Progressive position leading to higher executive post. Write full details to Managing Director.—BOX No. E5501, "The Engineer." A

SENIOR DESIGN DRAUGHTSMEN urgently required by light engineering company situated in Surrey. Applicants should possess H.N.C. or equivalent and have had practical workshop experience. These are senior positions and every opportunity exists for advancement. Salary up to £850 per annum. Contributory pension scheme. Apply in writing stating age and qualifications to—BOX No. E5461, "The Engineer." A

SENIOR DESIGNING DRAUGHTSMAN, with crane and structural experience or similar, with minimum of O.N.C. or equivalent standard, for aerial ropeway design office. Salary in excess of A.E.S.D. rates proportionate to ability and experience. Permanent position with ample opportunity for advancement.—BOX No. E2250, "The Engineer." A

SENIOR MECHANICAL ENGINEERING DRAUGHTSMEN required for interesting work on large chemical plant installations. Experience in this type of work is desirable but not essential, applicants with general mechanical engineering experience will be favourably considered. The posts offer excellent opportunities with generous salaries commensurate with experience and ability. Offices situated in the N.W.1 London area. Five-day week and superannuation scheme.—Applications, which will be treated in confidence, should give previous experience and qualifications and be addressed to the Chief Draughtsman, Laporte Chemicals, Limited, Clifton House, Euston Road, London, N.W.1. E733 A

SENIOR STRUCTURAL DESIGNER-DRAUGHTSMEN and capable Detailers required by Ashmore, Benson, Pease and Co., Stockton-on-Tees. Must be accustomed to design and detail steel-framed buildings, bunkers, pipe bridges, &c., for industrial plants. Maximum assistance given in obtaining accommodation, pension scheme, technical library and sports facilities available.—Apply, stating age, experience, &c., quoting reference "F," to Staff Personnel Officer. E716 A

STRUCTURAL DESIGNERS. — A unique opportunity for ambitious men. A number of Designers are urgently wanted by a progressive and rapidly expanding company. The work is varied and interesting and offers a first-class opportunity for really good men. B.S.P. Industries, Ltd., Dept. SD/7, Elstree Way, Boreham Wood ('phone: ELStree 3311/5). E2282 A

STRUCTURAL DRAUGHTSMAN required for a permanent post in Bath, salary £12 per week upwards according to ability. Please apply giving full particulars of experience and qualifications to—BOX No. E5440, "The Engineer." A

SEVERAL GRADUATE ENGINEERS are required for interesting technical, design and development work on Internal Combustion Engines. Applicants must hold a Degree in Mechanical Engineering and have practical experience. Excellent prospects are offered with a commencing salary of £750 to £1000 depending upon experience.—Apply in writing to the Chief Engineer of Design, Crossley Brothers, Ltd., Openshaw, Manchester, 11. E2335 A

TECHNICAL AND SALES ENGINEER required, knowledge of heavy steel works cranes and previous outside experience preferable. A salary commensurate with experience would be paid. A pension scheme is in operation.—Apply giving age and details of experience in chronological order to Adamson-Alliance Co., Ltd., 165, Fenchurch Street, London, E.C.3. E2333 A

TECHNICAL ASSISTANT required for development work on controls for the gas industry. Age 20–24. National Service completed. Qualified or studying for H.N.C. or similar background.—Apply with full particulars to Technical Manager, Engineering Division, Evered and Co., Ltd., Surrey Works, Smethwick 40. E5499 A

TECHNICAL ENGINEERS

The Aircraft Division of The Bristol Aeroplane Company, Limited, has vacancies at Filton for Technical Engineers in the Engineering Development Laboratory.

The work covers a wide field of general aircraft structural and mechanical test rig design and testing, materials tests, fatigue tests, and the development and use of electronic equipment. The facilities are some of the most modern and extensive in the country, and a wide range of work is in progress.

There are vacancies in Junior, Intermediate and Senior grades. The qualifications required are a Degree or Higher National Certificate, or equivalent, in an appropriate field, and some experience of similar work, with a knowledge of aircraft drawing office practice for the Intermediate and Senior grades.

Good salaries, working conditions and prospects, together with the pension and welfare schemes, make employment with the Company an attractive proposition well worth considering.

Applications, giving details of experience, qualifications and salary required, quoting D.O.43, should be addressed to the Personnel Manager, The Bristol Aeroplane Company, Limited, Aircraft Division, Filton House, Bristol. E5485 A

TECHNICAL ILLUSTRATOR required by leading electronic engineering company in S.W. London. Interesting work and good opportunity for young draughtsman with a flare for perspective sketches and instruction book illustrations. Pension fund.—Write Ref. TI/SJM, Decca Radar, Ltd., 1/3, Brixton Road, London, S.W.9. E5409 A

TECHNICAL WRITER (RADAR) required by manufacturer in the London area to compile literature on radar equipment. A good general educational and engineering background is necessary, with H.N.C. (including electronics) as the minimum technical standard. The principal requirement, however, is the ability to assimilate information supplied by laboratory technicians and to prepare this in a clear logical sequence suitable for publication as a handbook. Salary will be commensurate with experience and ability, but a minimum of £750 per annum is offered and, for a qualified radar engineer who is able to meet the requirements described above, there is scope beyond the position now vacant. Write in confidence, giving full particulars of past experience, qualifications, age and salary required.—BOX No. E5360, "The Engineer." A

TEXTILE MACHINERY MAKERS, LTD.,
require
GENERAL MANAGER
for their subsidiary company,
PLATTS (BARTON), LTD.,
URMSTON, MANCHESTER.

A man of outstanding calibre and record, with strong engineering qualifications and good knowledge of modern foundry practice is required. He will preferably have an Engineering Degree and must have had successful experience in large-scale management and administration.

The salary and generous non-contributory pension and life insurance arrangements will fully recognise the considerable responsibility of the post, which affords ample opportunities for further advancement.

Applications, in strict confidence, should be addressed to :—

THE MANAGING DIRECTOR,
TEXTILE MACHINERY MAKERS, LTD.,
HARTFORD WORKS, OLDHAM

marked "General Manager."

They should give age, full details of experience and names of referees, who will only be approached by agreement. E5357 A

THE BRITISH OXYGEN COMPANY LIMITED require two Mechanical Draughtsmen for work at their head offices in the West End of London. Applicants should have had some experience of plant layout work. The positions are permanent and offer very good prospects.—Reply, giving full details of age, experience and qualifications, to Personnel Manager, The British Oxygen Company Limited, Bridgewater House, Cleveland Row, St. James's, London, S.W.1. E5515 A

THE STANTON IRONWORKS COMPANY, LIMITED, Near Nottingham, invites applications for the appointment of Assistant Works Manager on its concrete plant. Applicants should have had a good general engineering training, including a knowledge of precast concrete construction, and preferably have held a similar position in the precast concrete products industry. A knowledge of prestressed concrete would be an advantage. The post is superannuated.—Write in confidence, giving age and full details of qualifications and experience, to the Staffing Officer. E5382 A

THE BRISTOL AEROPLANE COMPANY LIMITED

APPRENTICES' SCHOOL

Applications are invited for one or more full-time teaching posts as assistant lecturer, Grade "A" (Burnham Scale) to teach workshop technology, mathematics and science subjects for City and Guilds workshop courses.

Good practical experience essential, and Higher National or Final City and Guilds Certificate, or equivalent in an engineering subject.

Appointments to date from 1st September, 1955.

Forms of application obtainable from Chief Personnel Officer, Filton House, Bristol. E5437

THE BRITISH ALUMINIUM COMPANY LTD., require an Engineer in the Engineering Department of their Rolling Mills, Milton, Stoke-on-Trent. The successful applicant will act as Assistant to the Sectional Engineer in the planning and control of maintenance on melting shop and rolling mill plant, equipment and services, together with associated extension and development work. This appointment, which will carry a good commencing salary, is one of some status and is permanent and superannuable. Canteen facilities available. Previous experience in the above fields not essential. Age 26–35 approx., technical qualifications, preferably to H.N.C. standard.—Written applications (in confidence) stating age, training, qualifications and experience to the Manager at the above address. E5

THE BRITISH PETROLEUM COMPANY LIMITED, invites applications from young Graduates with a Degree in Engineering, Physics, Mathematics or Natural Philosophy to be trained as Petroleum Engineers. Training will last for approximately two years and will take place partly in the United Kingdom and partly overseas. On successful completion of the training, men will be posted as Resident Petroleum Engineers to exploration areas overseas. Age preferably not over 26, National Service obligations must have been fulfilled.—Write, stating age and full details of qualifications and experience, quoting H.2089, to BOX 7645, c/o 191, Gresham House, E.C.2. E6

THE CONISTON COMPANY
require
SENIOR DRAUGHTSMEN
to work in their Wimbledon Office and in Central London.
With experience of :
(a) Chemical Plant Layout.
(b) Piping.
(c) Pressure Vessel Design.
(d) Steel and Concrete design and detailing.

Salaries according to qualifications and experience. The Coniston Company, Eagle House, High Street, Wimbledon, S.W.19.—WIM 1191. E2

TRACERS required by consultants in Westminster for work on civil, mechanical and electrical engineering and shipbuilding. Preference given to those with experience in electrical and shipbuilding. 9.30–5.30 and one Saturday morning in six, 3 weeks paid holiday this year. Phone Sloane 0[illegible] E6

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World famous Middle West

MACHINE TOOL MANUFACTURER

offer permanent positions with much future prospect for Machine Tool

PROJECT ENGINEERS
CHIEF DESIGNERS
DESIGNERS

Only those anxious to make their future in America need apply. The company does not wish to offer higher remuneration to wean from present employers individuals seeking only short term employment and overseas experience. Applicants should send full information of education, technical training, and should submit in the first detail a record of their experience by letter to

Edward S. Tallmadge,

Hotel Baur au Lac, Zürich, Switzerland.

Mr. Tallmadge will be in England shortly to interview applicants. In order that he may see the most suitable applicants for interview he requests that they provide him with as much information as possible, and that they do not leave it to refer to past or present employers or colleges for record.

VACANCIES with particularly good prospects have occurred for two qualified Engineers, aged 22–28, with a national organisation. After a period of training in the Company's processes, appointments will be made to the Production Management staff. These vacancies occur in two of the main industrial areas of the country and as far as possible appointments will be made to those branches nearest the applicant's home. Reply, stating full details of age, qualifications and experience.—BOX E5509, "The Engineer." A

VACANCY FOR ENGINEER to run collection of plant and maintenance of tractors and other farm machinery. Good house on farm.—Apply The Grove Farms (Harwell), Ltd., Wood Farm, Milton Hill, Abingdon, Berks.

WORKS MANAGER required for medium-sized machine tool manufacturers employing about 200 people in Manchester area. State qualifications, experience and commencing salary expected.—BOX No. E5496, "The Engineer."

SITUATIONS VACANT

VACANCIES EXIST in the Works Engineer's Department of a large company in East London for personnel capable of planning layouts for both machine and assembly shops from information supplied by The Time Study Departments, also experience in ventilation and extraction systems, palletisation and mechanical handling of stores, &c. Age between 30 and 40. A good salary will be paid to the selected candidates. Please write, giving details of experience.—BOX No. E5407, "The Engineer." A

VICKERS-ARMSTRONGS LIMITED (AIRCRAFT DIVISION)

REQUIRE :—REINFORCED PLASTICS—LABORATORY ASSISTANTS required for interesting work on the development of plastic structures for Guided Weapons. Academic qualifications, though desirable, are not essential, but some practical experience of work with glasscloth and low pressure resins is necessary.

Applications, quoting date and prefix letter of advertisement, to : Employment Manager, Vickers-Armstrongs Limited (Aircraft Division), Weybridge Works, Weybridge, Surrey.

Weybridge is 30 minutes from London on the main Waterloo/Portsmouth line.

Additional 'buses operate to and from the works at starting and finishing times.

Canteen facilities.

Applicants should be in a position to arrange their own housing accommodation. Assistance can only be given with individual lodgings.

Holidays already arranged by applicants for this year taken into account. E5368 A

WILMOT-BREEDEN LIMITED
Amington Road, Birmingham, 25.

LABORATORY MANAGER

Applications invited with view to appointing Manager for Laboratory dealing with routine control of electroplating on a large scale, metallurgical control of ferrous and non-ferrous materials, examination and control of paints, certain plastic materials, greases and oils. Also life testing of small mechanisms.

Applicants should have had extensive experience of industrial laboratory procedures, have specialised at one time during career on either electrochemistry or metallurgy.

Position offers substantial status, adequate salary according to experience and qualifications, contributory and supplementary pension scheme.

Applications in strictest confidence, should be addressed to Personnel Manager and clearly marked "Laboratory Manager." E5512 A

WORKS MANAGER

If your own interest read this advertisement carefully, and if you think you have the experience, the personality, initiative, drive and doggedness to make a success of the appointment, apply at once to BOX No. E2325, "The Engineer."

A well-known firm in the Midlands requires a sound, practical man with considerable works experience, as Works Manager. Preference will be given to applicants with background of good engineering apprenticeship with H.N.C. and an up-to-date knowledge and actual experience of tool making, power and light press work, metal fabrication, material processing, welding of ferrous and non-ferrous metals and of sound production methods. An appreciation on modern methods of production and cost control would help.

To the right man, not afraid of hard work, accustomed to accepting responsibility and taking decisions and to controlling a mixed labour force in excess of 500, this appointment represents an opportunity for further progress. A commencing four-figure salary and admission, after probationary period, to an attractive pension scheme.—BOX No. E2325, "The Engineer." A

WORKS MANAGER.—Capable man required will be first appointed as Assistant Works Manager, to train with a view to taking over position of Works Manager at an early date. Knowledge of light-heavy industry is essential, coupled with good planning ability and adequate knowledge of modern production methods. Birmingham area. Attractive salary will be offered and prospects are first class.—BOX No. E2343, "The Engineer." A

WORKS MANAGER required by well-known Wolverhampton company to control modern machine and assembly shops producing light non-ferrous components. Strength of character, administrative ability and general engineering background essential, including machine shop experience of bar, capstan, automatics and capstans. Age 32–38. Salary and bonus about £1200, depending on experience and capability. Write, giving full details.—BOX E2336, "The Engineer." A

WORKS MANAGER required for large general engineering works, Midlands. Position requires experienced and qualified Engineer capable of planning and supervising new production methods and large variety of medium and heavy engineering products. Excellent opportunity with good prospects. Pension scheme. Only first-class, experienced workers considered. Apply, in strict confidence giving fullest details of training, experience, present and past employment, age, &c.—BOX No. E2344, "The Engineer." A

SITUATIONS WANTED

CHIEF ENGINEER, age 39, five years' executive, internationally known company, immediately available. Previously chief draughtsman, process industries projects. Large staff, overseas experience. Well-travelled, experienced sales and budget management.—BOX No. E2319, "The Engineer." B

ENGINEER of 34, single, G.I.Mech.E., fluent in German and French, requires position as Assistant to Works Manager in engineering company. Experience in machine and jig and tool design, development of production methods, good at personnel relations. Grammar school education, H.N.C. (Mechanical), with endorsements, exemption parts A, B, C of the Institution examinations.—BOX No. E2318, "The Engineer." B

ENGINEER (30), B.Sc. (Eng.), A.M.I.Mech.E., M.S.I.T., seeks progressive post. Experienced in design, installation and maintenance of chemical plant, services, instrumentation, refrigeration, &c. Salary required £1300 p.a. upwards.—BOX No. E2351, "The Engineer." B

MECHANICAL ENGINEER seeks Executive position. Training and experience covers wide field in machine shop practice, plant erection and maintenance ; also technical development in heavy and light engineering, gas and chemical plant practice. Has held positions as works and plant engineer. Please reply.—BOX No. E2320, "The Engineer." B

MECHANICAL ENGINEER, fully qualified (40), vast experience home and abroad, oil, chemical and industrial plants, layout and installations, seeks progressive Post.—BOX No. E2308, "The Engineer." B

REPRESENTATIVE or Sales Engineer, B.Sc., well connected, home and abroad, heavy equipment, power plants and mining machinery, desires position of responsibility where initiative is required.—BOX No. E2309, "The Engineer." B

WELL-KNOWN STRUCTURAL ENGINEER (49), M.I.Struct.E., A.M.I.C.E., with substantial background, executive and administrative, abreast of developments in research and construction, seeks a Partnership, Directorship, or other position of responsibility. Capital available.—BOX No. E2350, "The Engineer." B

WORKS MANAGER (41), light engineering, seeks senior appointment, home or abroad, progressive companies seeking future General Manager. Present salary £1500.—BOX No. E2322, "The Engineer." B

AGENCIES

AGENTS required to sell to all branches of industry new type of lubricating oil gun.—Sir Thomas Edelston and Partners, Ltd., 28–30, Sussex Place, London, W.2. E5494 D

AGENT, Chartered Engineer, operating in S.W. England and South Wales, having established connections with Industrial Factories, Electricity Boards and Architects, is open to accept representation for substantial manufacturers of plant and equipment.—BOX No. E2349, "The Engineer." D

BUSINESS OPPORTUNITIES

ENGINEER (experienced top-level contacts) offers London Office, Calls by Car, 'Phone, &c.; £400 p.a. inclusive or similar arrangement.—BOX No. E2311, "The Engineer." O

ENGINEERING COMPANY in London area with modern versatile plant interested in manufacturing new products, also interested in suitable patents and ideas for purchase or manufacture on royalty basis. Brief details in first instance and in absolute confidence.—BOX No. E2330, "The Engineer." O

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Buyers requiring Rigid and Flexible Tubes and Sections in Thermoplastic Materials should ask for a quotation from :

MARLEY EXTRUSIONS LTD.
DEPT. 145,
LENHAM, MAIDSTONE, KENT.
Harrietsham 381. E739 O

SUB-CONTRACTING

CAPACITY AVAILABLE

ANDREW BARCLAY, SONS & CO., LTD., Caledonia Works, Kilmarnock, Scotland (Tel. Kilmarnock 1366/7), have some capacity available for the manufacture of industrial locomotive boilers, steam receivers, pressure vessels, and waste heat boilers, or similar plate work. Quick delivery can be given, together with competitive prices.

London Office, 38, Victoria Street, Westminster, S.W.1 (Tel., Abbey 6407). E5497 MW

CAPACITY AVAILABLE

Old Established Engineering Works has capacity for all types of MILD STEEL FABRICATION up to 5 tons unit weight, GREY IRON CASTINGS up to 20 cwt. unit weight, MACHINING and GEAR CUTTING, ASSEMBLY of FINISHED PARTS UNDERTAKEN, stocks of SEASONED ENGLISH TIMBER available, well equipped woodworking department. Adjacent to Docks with our railsiding.

SAVAGES LIMITED,
King's Lynn (Tel. 3678/9), Norfolk.
E9878 MW

CASTINGS.—We can save your porous castings ferrous or non-ferrous, by an approved impregnation process ; sample castings treated ; A.I.D. approved —Recupero. Ltd., 66, South Harrow Viaduct, Harrow, Middlesex ('Phone, Byron 1178). E575 MW

FAIRMAN PRECISION TOOLS and Products, Ltd., of Horley, Surrey, manufactures Plastic Moulds, Jigs and Fixtures, Press Tools, Special-Purpose Machines, &c.—'Phone Horley 3678. E619 MW

SUB-CONTRACTING

GEO. MILLS (ENGINEERS), LTD., of Beckenham, Kent, can handle your awkward jobs, prototypes, special purpose machines ; also machining, grinding, forging, welding, &c. A.I.D. and A.R.B. approved.—Tel. Sydenham 5255. E748 MW

KELLERING AND PROFILE MILLING in all metals. Send us your die blocks to copy from wood or plaster masters. Up to 5ft. by 8ft. max. size. We are die copiers to the trade.—Armytage Bros. (Knottingley), Ltd., The Foundry, Knottingley, Yorkshire (Tel., Knottingley 46). E540 MW

PRATCHITT BROTHERS, LTD., Denton Iron Works, Carlisle, having well-equipped engineering shops and iron foundry, invite enquiries for General Engineering, Structural and Platework, from firms wishing to have plant made to their own designs and specifications. E751 MW

PRECISION ENGINEERS.—Personal service for prototypes, small quantity machined parts and equipments. Design undertaken. A.I.D. Approved Mech. and Elect.—Cathanode, Limited, Vineyard Walk, Clerkenwell, E.C.1 ('Phone, TERminus 5113–4). E650 MW

TUBE BENDING SERVICE offered for ferrous and non-ferrous tubes up to 4in. N.B. Keen quotations given upon receipt of full details.—BOX No. E641, "The Engineer." MW

DRAWING & DESIGN SERVICE

DESIGN OFFICE CAPACITY available for mechanical and production engineering, special machines and projects.—Norris Brothers, Ltd., 53 Victoria Street, London, S.W.1 (Tel., Abbey 5444). E710 S

FOR HIRE

LATTICE STEEL Erection Masts (light and heavy), 30ft. to 150ft. high for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. ('Phone, SLOane 5259.) E112 K

MISCELLANEOUS

TIME RECORDERS, Sales, Rental, Service, Telephone Hop 2239.—Time Recorder Supply and Maintenance Co., Ltd., 157-159, Borough High Street, London, S.E.1. E608 C

MACHINERY Etc. WANTED

STEEL CHIMNEY required, 30ft. long, ⅜in. steel, 18in. inside diameter. Preferably in 15ft. lengths.—BOX No. E2340, "The Engineer." F

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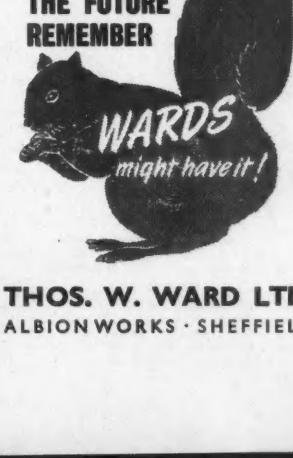
For continuation of Small Advts., page 136



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For continuation of Small Advts., page 1

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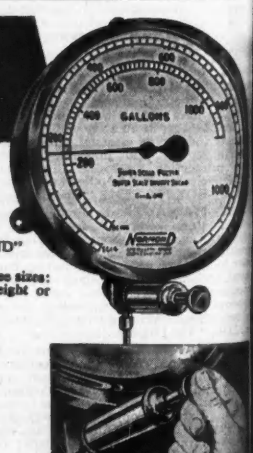

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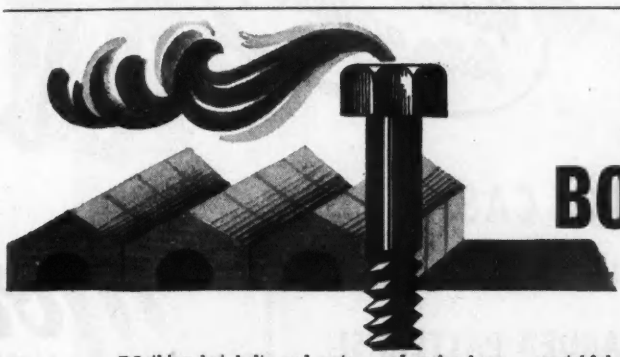

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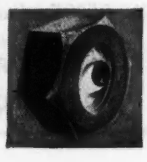

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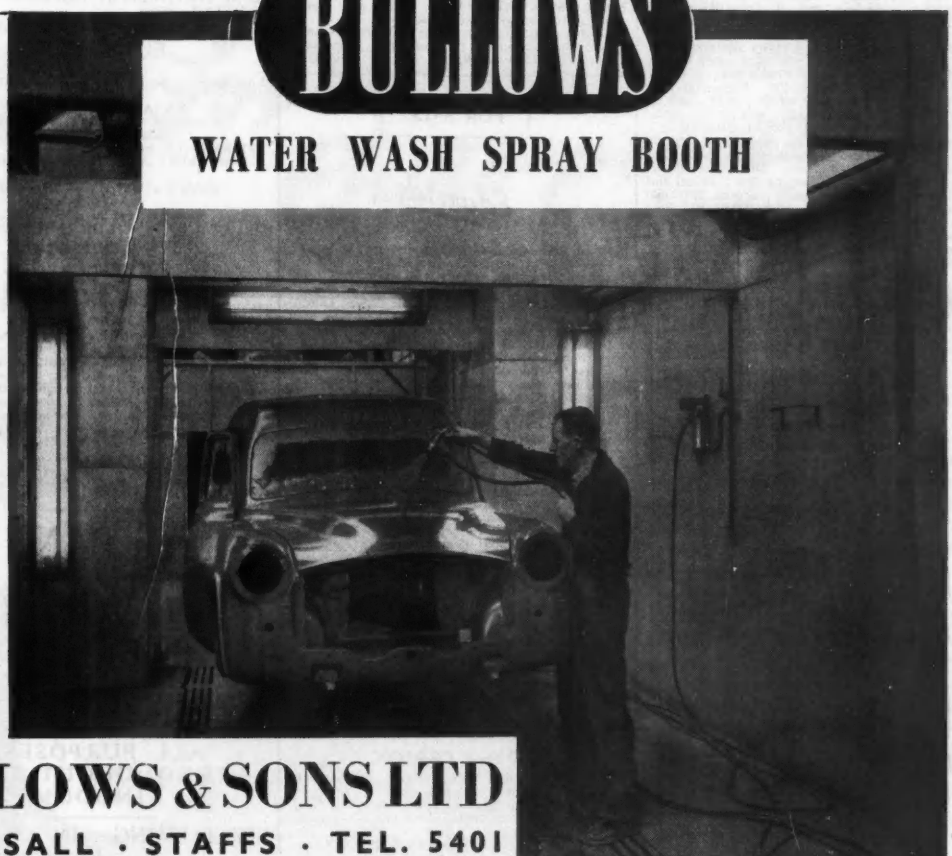

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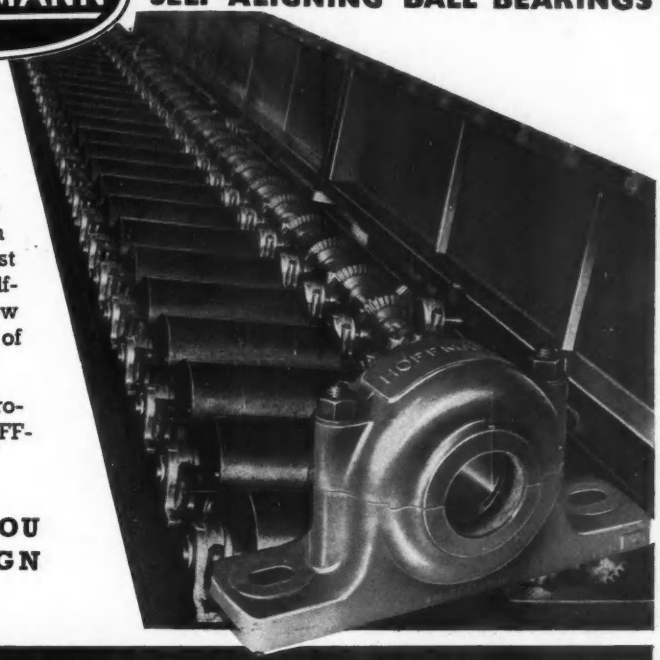

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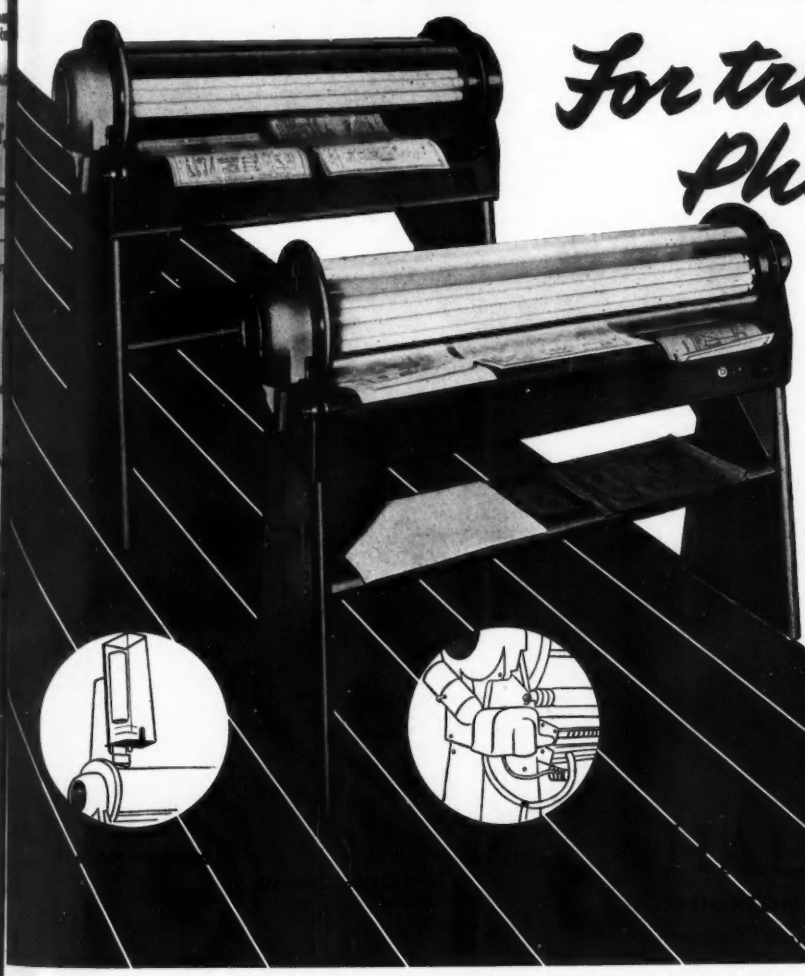

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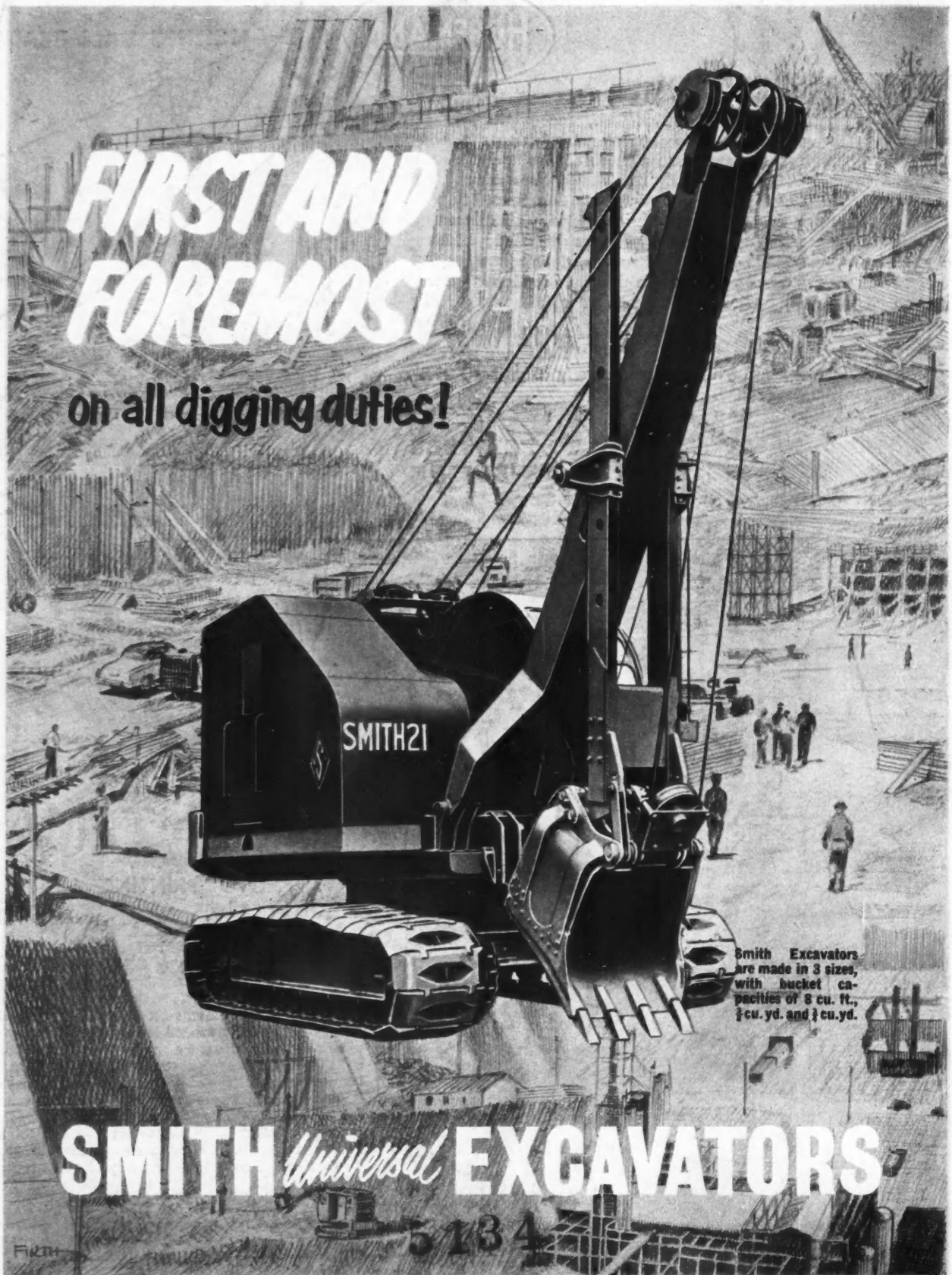
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